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PSYCHE

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NOTES ON HIPPOBOSCIDAE

2. THE SUBFAMILY HIPPOBOSCINAE

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Although much has been written concerning some of the common species of Hippobosca that infest equines and cattle, no comprehensive and critical account of the genus as a whole has been published thus far. The present attempt at filling this gap cannot be more than preliminary, especially with regard to the synonymy adopted for the many names proposed in this group. In no case have I had access to the types on which these names were based.

The genus Hippobosca occupies an isolated position in the family Hippoboscidæ, forming a subfamily of its own, which was first defined by Speiser (1908, Zeitschr. Wiss. Insektenbiol., IV, p. 445).

Subfamily **Hippoboscinae**

Head rounded posteriorly, entirely free from the anterior margin of the thorax. Antennal pits completely enclosed by a continuous rim, containing the small, subglobular antennæ, which have no dorsal prolongation. No ocelli. Pronotum well developed dorsally, visible between the head and the mesonotum. Humeral angles rounded off, not projecting. Claws simple, but apparently bidentate, without supplementary tooth between the sharp apex and the broad, flattened "heel" of the base. Wings always well developed and functional throughout adult life; six distinct longitudinal veins and a vestigial seventh vein between the fifth ($M_{3+}Cu_1$) and sixth (An); two cross-veins, the anterior (r-m) and the anterior basal (m-cu or M_3); second basal cell very long; no closed anal cell; membrane bare, but rilled with numerous delicate, more or less parallel wrinkles, extending from the region of distinct veins toward the hind margin.

The subfamily contains only one genus.

Hippobosca Linnæus

Hippobosca Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (type: *Hippobosca equina* Linnæus, 1758, designated by Latreille, 1810, Considér. Génér. Crust. Arachn. Ins., pp. 407 and 444).

Hippobosca subgenus *Nirmomyia* Nitzsch, 1818, in Germar's Mag. d. Entom., III, p. 309 (monotypic for *Hippobosca equina* Linnæus, 1758).

Zoomyia Bigot, 1885, Ann. Soc. Ent. France, (6) V, pp. 227 and 234 (tentatively proposed as a substitute for *Hippobosca;* type by present designation: *Hippobosca equina* Linnæus, 1758).

Attention may be called to the remarkable structure of the pulvilli and empodium, which in this genus offer excellent specific characters.

The genus Hippobosca is indigenous throughout the continental areas of the Old World. All of the eight species, which I recognize as valid, are found in Africa; four of them extend also into the Oriental Region and two have entered Europe. Much of the present distribution of *H. equina, H. camelina, H. maculata,* and *H. capensis* is undoubtedly artificial and due to the spreading of their domestic hosts by man. I have tried to trace the probable original home of these species, but the conclusions I have reached are far from satisfactory.[1] None of the species appear to have become naturalized in the New World, where their occurrence is very accidental.

With one exception, the species of Hippobosca are ectoparasites of mammals, mainly of Ungulates and Carnivora. *H. struthionis,* however, is a normal parasite of the ostrich. Since the Ungulates and Carnivora were more numerous and more widely distributed in Mesozoic times than nowadays, it is safe to assume that Hippobosca has had a long geological past and may have been at one time cosmopolitan. The few living species are perhaps only the remnants of a large group of parasitic flies, which may have been as numerous in species as the living Hippoboscidæ of birds.

The Hippoboscæ are fairly good fliers. The gravid female leaves the host and deposits the full-grown larva in cracks of walls, in holes of trees, or on the ground. Patton, for instance, observed a female of *H. capensis* leave a dog, fly onto a wall and, after running along it, rapidly disappear into a crack. The fly remained there a few minutes; as it emerged, it was caught, and, on examining the crack, a larva was found a little distance inside (Patton and Evans, 1929, "Insects, Ticks, etc., of Medical and Veterinary Importance," I, p. 404).[2]

Host specificity is not very pronounced among the Hippoboscidæ which retain the wings throughout adult life, and this statement applies particularly to Hippobosca. Only the species of the ostrich seems to be restricted to a single host-species. *H. fulva, H. hirsuta* and *H. camelina* also have a narrow range of normal hosts. The other species have nowadays a variety of usual hosts; but in some cases this may be an artificial condition, due to the influence of man. Spreading of certain species by man beyond their original home may perhaps explain partly why more than one species of Hippobosca infest nowadays domestic equines and cattle. I have attempted to distinguish in a table between the "normal" and the "facultative" or "accidental" hosts, in so far as feasible.

---

[1] There is a voluminous literature dealing with the ancestors of domestic animals. After consulting a number of publications, I have found what appears to be the most reliable information in Keller, Conrad, 1902. "Die Abstammung der altesten Haustiere," (Zurich), 232 pp.

[2] I have not found any evidence that the puparia of Hippobosca are ever placed among the fur or feathers of the host, as Theobald (1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92) has claimed.

	Normal Hosts	Facultative and Accidental (Acc.) Hosts
H. equina	domestic equines	cattle (Acc.: dog, rabbit, camel, birds)
H. capensis	domestic dog, lion, leopard, hyena, cheetah, civet, fox, serval	duiker, dik-dik (Acc.: mule)
H. fulva	hartebeest	
H. maculata	domestic equines and cattle	camel, dromedary
H. rufipes	domestic equines	domestic cattle, wildebeest, eland, giraffe (Acc.: ? ostrich)
H. hirsuta	waterbuck and allied antelopes	
H. struthionis	ostrich	
H. camelina	camel, dromedary	horse (? Acc.)

The following alphabetical list of 36 names will serve as an index to the synonymy here adopted:

albo-maculata Macquart=*rufipes* v. Olfers.
albonotata Rondani=*rufipes* v. Olfers.
bactriana Rondani=*camelina* Leach.
bengalensis Ormerod=*maculata* Leach.
bipartita Macquart=*maculata* Leach.
calopsis Bigot=*maculata* Leach.
cameli Leach=*camelina* Leach.
8. *camelina* Leach. A valid species.
camelopardalis Roubaud=*rufipes* v. Olfers.
canina Rondani=*capensis* v. Olfers.

2. *capensis* v. Olfers. A valid species.
chinensis Giglioli=*capensis* v. Olfers.
cunicosa Thalhammer=*capensis* v. Olfers.
dromedarina Speiser=*camelina* Leach.
egyptiaca Macquart=*maculata* Leach.
equi Macquart=*equina* Linnæus.
1. *equina* Linnæus. A valid species.
fossulata Macquart=*maculata* Leach.
francilloni Leach=*capensis* v. Olfers.
3. *fulva* Austen. A valid species.
6. *hirsuta* Austen. A valid species.
laticornis Macquart=*capensis* v. Olfers.
longipennis Fabricius=probably *capensis* v. Olfers.
4. *maculata* Leach. A valid species.
maculata Macquart=*rufipes* v. Olfers.
marginata v. d. Wulp=*rufipes* v. Olfers.
massaica Speiser=*struthionis* Janson.
neavei Austen=*hirsuta* Austen.
orientalis Macquart=*capensis* v. Olfers.
5. *rufipes* v. Olfers. A valid species.
sivæ Bigot=*maculata* Leach.
7. *struthionis* Janson. A valid species.
sudanica Bigot=*maculata* Leach.
taurina Rondani=*equina* Linnæus.
variegata Wiedemann=*maculata* Leach.
wahlenbergiana Jænnicke=*rufipes* v. Olfers.

KEY TO SPECIES OF HIPPOBOSCA

I have studied specimens of the seven valid species separated by the subjoined key, which I have attempted to base mainly upon reliable structural characters. I have found that the coloration, although often helpful, is rather variable in certain species, and I do not regard it as of specific value when no differences in structure can be discovered.

Hippobosca fulva Austen appears to be distinct from the other seven. I have not seen it, and the characters given in the description do not allow of its being included in my key.

1. Second longitudinal vein (R_{2+3}) long, reaching the costa much beyond the tip of the first longitudinal (R_1) and apicad of the anterior cross-vein; the last section of the costa at most three times the length of the penultimate section. Base of third longitudinal vein (R_{4+5}) bare. One pair of vertical bristles. Two pad-like pulvilli at the sides of the bristle-like empodium, one much larger than the other 2

Second longitudinal vein short, reaching the costa together with or close to the tip of the first longitudinal; the last section of the costa equal to at least five times the distance between the tip of the first and that of the second longitudinal veins 3

2. Apical lobes of the fronto-clypeus regularly and sharply triangular, their inner margins nearly straight. Scutellum as a rule wholly ivory-white; wing veins mostly pale testaceous, with some darker stretches. Smaller, the wing 5 to 6 mm. long .... *H. capensis*

Apical lobes of the fronto-clypeus irregularly and broadly triangular, their inner margins curved. Scutellum fuscous to ferruginous on the sides, yellowish white in center, rarely more extensively yellowish; wing veins as a rule rufous to dark brown. Larger, the wing 6 to 8.5 mm. long .... *H. equina*

3. Base of third longitudinal vein setulose over some length on the upper side. One pair of vertical bristles. Only one pulvillus well developed, the other rudimentary 4

Base of third longitudinal vein bare 6

4. Second longitudinal vein very short, forming an oblique cross-vein which ends in the first longitudinal and runs from opposite or apicad of the upper tip of the anterior basal cross-vein to basad of the anterior cross-vein. Scutellum as a rule with three ivory-white spots, the largest in the center; bristles of head and thorax pale. Large, the wing 7 to 8 mm. long ....*H. maculata*

Second longitudinal vein much longer and more oblique, ending in the costa close to or at the tip of the first longitudinal and running from basad of the upper tip of the anterior basal cross-vein to opposite or basad of the anterior cross-vein 5

5. Vertex distinctly narrower at the occiput than at the fronto-clypeus in both sexes. Scutellum very wide and nearly rectangular, with a median, rufous, and two lateral, ivory-white spots. Legs bright reddish; bristles of head and thorax brownish black. Larger, the wing 7 to 9 mm. long .... *H. rufipes*

Vertex about as wide at the occiput as at the fronto-clypeus. Scutellum narrower and less rectangular, with a median, ivory-white spot. Legs rufous-yellow; bristles of head and thorax pale. Smaller, the wing 6.5 to 8 mm. long .... *H. hirsuta*

6. Two pairs of vertical bristles. Sclerotized upper plate of vertex (or vertical triangle) about as long as wide at the occiput, much shorter than the medio-vertex, the latter considerably narrowed in the middle by the very broad inner orbital plates. Apical lobes of fronto-clypeus broadly separated by a semi-elliptical notch. Second longitudinal vein ending in the tip of the first, opposite the anterior cross-vein. Anterior basal cross-vein very oblique and nearly its own length from the anterior cross-vein. Scutellum semi-elliptical in outline, its posterior margin distinctly convex and slightly projecting in the middle. No pad-like pulvilli; the bristle-like empodium bare, except at the base. Larger, the wing 9 to 10 mm. long .... *H. camelina*

One pair of vertical bristles. Sclerotized upper plate of vertex longer than wide at the occiput, as a rule longer than the medio-vertex, the latter moderately narrowed by the inner orbital plates. Apical lobes of the fronto-clypeus separated by a narrow notch. Second longitudinal vein reaching the costa close to the tip of the first and apicad of the anterior cross-vein. Anterior basal cross-vein short, almost vertical upon the fourth longitudinal and more than twice its own length from the anterior cross-vein. Scutellum subrectangular, broadly truncate at the apical margin, not projecting in the middle. Two pad-like pulvilli; the empodium feathered. Smaller, the wing 7 to 7.5 mm. long .... *H. struthionis*

1. **Hippobosca equina** Linnæus

Hippobosca equina Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (no sex given; Europe and North America). Austen, 1906, "Illustr. Brit. Blood-Suck. Flies," p. 63, Pl. XXXI. Newstead, Dutton and Todd, 1907, Ann. Trop. Med. Paras., I, p. 90, figs. 17 (♀) and 18 (puparium). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 49, Pl. IV, figs. 3 and 4 (♀ ♂).

Hippobosca equi Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638, Pl. XXIV, fig. 8 (error for *H. equina*).

Hippobosca taurina Rondani, 1879, Boll. Soc. Ent. Italiana, XI, pp. 24 and 25 (no sex given; off cattle in central Italy).

Specimens Examined.—Sweden: (Ljungh). Germany: Berlin. Spain: Montanegos (Cevera); Escurial; Iviza, Baleares (W. M. Wheeler). France: Banyuls-sur-Mer, Pyr. Or., off a dog (G. Dimmock). Sardinia: (Krausse). Turkey: Reshadie (H. R. Hagan). Egypt: (S. H. Scudder). New Caledonia: Plum Farm (T. D. A. Cockerell). Belgian Congo: Kitobola, two males, 1913 (Rovere). Philippines: Manila (M. J. Myers).

Distribution.—This common species is known in England as the "forest-fly," after the New Forest in Hampshire, where it is particularly abundant. It may have been at first restricted to southern Europe and western Central Asia; but nowadays it is found throughout Europe (as far north as Lapland, and also in the British Isles), Northern Africa (as far south as Biskra), the Canary Islands, Madeira, the Azores, the Senegal, the Anglo-Egyptian Sudan, Egypt, Palestine, Asia Minor, India, the Sunda Islands, the Philippines, Celebes, Fiji, the New Hebrides and New Caledonia (introduced about 1890). It has been seen on freshly imported horses in Australia, but it does not seem to have become established there. Linnæus (1758) mentioned North America as part of the habitat and Loew [1864, Amer. Jl. Sci. Arts, (2) XXXVII, p. 318] included it among the species of Diptera common to Europe and America. It is doubtful, however, whether either Linnæus or Loew actually saw American specimens. Loew's record may have been based upon the earlier statement by W. Kirby (1837, Fauna Boreali-Americana, IV, p. 317; see Bethune, 1881, Canad. Entom., XIII, p. 169), who listed *H. equina* among the insects of Boreal America, without, however, mentioning a definite locality. Notwithstanding certain discrepancies, Kirby's description seems to have been based upon a specimen of true *equina;* but whether or not it came from North America is open to question. In any case, no other entomologist seems to have reported this fly from a New World locality, and I have never seen an authentic American specimen in any collection. Moreover, it is somewhat of a mystery why this fly has not become established in America, since it must have been brought over repeatedly from the Old World.

Newstead, Dutton and Todd (1907) state that they saw a few examples of *H. equina* on cattle, shipped at Las Palmas, Canary Islands, while on board ship on their way to the Belgian Congo. But the two specimens which I have seen from Kitobola are the only ones actually taken in tropical Africa, where *H. equina* seems to be replaced by *H. maculata.* Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1140) includes the Cape Colony in the range of the species, but no specimens have since been taken in South Africa.

HOSTS.—*H. equina* is usually found on equines (horses, mules and donkeys), sometimes also on cattle and more rarely on dogs, rabbits, or camels. Accidentally it may stray to birds. Massonat (1909, Ann. Université Lyon, N. S., CXXVIII, p. 242) saw specimens from owls (*Tyto flammea*) and from a kite (*Milvus regalis*), and Schuurmans-Stekhoven captured one on a pigeon. It is of interest that this species has never been taken on the wild equines of Africa.

The predilection which *H. equina* shows for horses makes it very probable that this insect was originally a specific parasite of one of the wild horses from which the domestic races have been derived. According to C. Keller (1902), the ancestor of the heavy races of horses was a wild equine which lived in Europe during the Pleistocene (*Equus caballus* Linnæus) and even survived until historic times. The lighter races, on the other hand, had an Asiatic origin and were most probably derived from *Equus przewalskii* Poliakoff, a wild equine of Central Asia, of which a few specimens may be living yet in a feral state in Dzungaria. I am inclined to the view that both these ancestral species were infested with *H. equina,* although, of course, this is a mere hypothesis. It may yet be possible to find the insect on the living *E. przewalskii.*

AFFINITIES.—*H. equina* and *H. capensis* appear to be very closely allied, although there can be no doubt that they are specifically distinct. After a very careful study, I have found that the only structural difference, which seems to be entirely reliable, is found in the shape of the fronto-clypeus. I had thought at first that the wing venation afforded some additional distinctive features. The relative distance from the tip of the second longitudinal vein to that of the first and third longitudinals appears to be highly variable. The length of the anterior basal cross-vein (or second basal cross-vein; *m-cu* or M_3) is perhaps more reliable: in *H. capensis* this cross-vein is fairly straight and, as a rule, about as long as the distance from its tip to the anterior cross-vein (*r-m*); in *H. equina* it is more curved and generally much longer than the distance from its tip to the anterior cross-vein.

In one male of *H. equina,* from Sardinia, the left wing has a double anterior cross-vein, enclosing a small supernumerary cell; the right wing is normal.

A further specific character may perhaps be found in the size and shape of the sclerotized upper plate of the vertex (vertical triangle). In all the 29 specimens of *H. equina* examined, this plate occupies about the upper third of the vertex, being at most half the length of the medio-vertex (or frontalia); it is almost semi-circular in outline and much wider at the occiput than long on the middle line. In most of the specimens of *H. capensis* seen, this upper vertical plate is much more extensive, being over half the length of the medio-vertex, sometimes occupying nearly half of the vertex; it is rather semi-elliptical and only a little wider at the occiput than long on the middle line. Unfortunately I have seen several specimens of *H. capensis* which in the shape of the vertex do not appreciably differ from *H. equina*. Nevertheless, this character may be of specific value, even though its variability prevents its being used in a key.

The color peculiarities of the scutellum and of the venation, which have been generally used as specific characters, I have found to be extremely variable and wholly unreliable in these two species. I have seen specimens of *H. equina* colored almost exactly like *H. capensis*, and I am certain that the two have often been confused in collections.

2. **Hippobosca capensis** v. Olfers

Hippobosca capensis v. Olfers, 1816, "De Vegetativis et Animatis Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen).

Hippobosca francilloni Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 8, Pl. XXVI, figs. 8-10 (no sex given; without locality). Theobald, 1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92, figs. 51 and 53*C*; Pl. X, fig. 1 (♀).

Hippobosca orientalis Macquart, 1842, Mém. Soc. Sci. Lille, p. 432, Pl. XXXVI, fig. 6; 1843, "Dipt. Exot.," II, 3, p. 275, Pl. XXXVI, fig. 6 [called *Hippobosca laticornis* in the Explanation of Plates, p. 294] (no sex given; East Indies).

Ornithomyia chinensis Giglioli, 1864, Quart. Jl. Micr. Sci., N. S., IV, p. 23, Pl. 1*B*, figs. 10 and 11 (no sex given; China; supposedly off *Turdus obscurus*).

Hippobosca canina Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 164 (no sex given; Italy, Southern Europe, Persia, South and East Africa).

Hippobosca cunicosa "Madarasz," Thalhammer, 1899, "Fauna Regni Hungarici, Diptera," p. 69 (without description).

Hippobosca longipennis Fabricius, 1805, "Syst. Antliat.," p. 338 (no sex given, Tranquebar), is probably also *H. capensis* v. Olfers. The very brief description is as follows: "H. alis obtusis corpore duplo longioribus, corpore ferrugineo immaculato. Minor *H. equina*. Caput et thorax ferruginea, immaculata. Abdomen brevissimum; segmento primo transverso, carinato. Alæ longissimæ, albæ. Forte mera *H. equina* varietas." Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 332) claims to have recognized this species in a specimen at the Genoa Museum, collected by Fea (1885) at Mandalay, Burma. He states that the wing venation is as in *H. equina*, but otherwise mentions only color characters. Later (1908, Zeitschr. Wiss. Insektenbiol., IV, pp. 301 and 443) Speiser regarded it as a typically Oriental species, differing from all others in the absence of pale markings. The only specimen he saw was about the size of *H. capensis* (wing 6.5 mm. long). I hesitate, however, to change the name of this well-known species until Fabricius' type can be critically studied.

SPECIMENS EXAMINED.—Tunis: Kairouan (F. Santschi). Egypt: Bab-el-Wadi, Assuan (Nasarey); Lower Egypt (Nasarey); Luxor (G. Allen), off *Vulpes vulpes egyptiaca* (Desmarest). Kenya Colony: Hills west of Mt. Kenya, off a spotted hyena, *Crocuta crocuta fisi* Heller, July 3, 1909 (G. M. Allen); Sabaki (L. Bayer); Campi Kiboko (L. Bayer); Kerio River (L. Bayer); Tsavo River (L. Bayer); Magadi Railway (C. M. Woodhouse). Tanganyika Territory: Saranda near Dodoma, off a serval, *Felis capensis hindei* Wroughton (A. Loveridge); Tabora, off a lion, *Felis leo* Linnæus (J. Rodhain); between Tabora and Kigoma (Stamper); 25 miles east of Ikoma, numerous specimens off a lion, and one male off a young leopard, *Felis pardus suahelicus* Neumann (J. P. Chapin); Dodoma, on man (A. Loveridge). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Japan: Kamagawa (J. T. Gulick). China: Wuchang (C. M. A. Wassell); Kao-Ghiao

(J. Hervé-Bazin); Suifu, Sze-Chuen (D. C. Graham); Soochow (N. Gist Gee); Nanking, off dogs (C. S. Low); Penniu (C. Y. Wong). India: Koolloo (M. M. Carleton). Tonkin.

DISTRIBUTION.—*H. capensis* is common in many parts of the Mediterranean Subregion (Italy, Sicily, Macedonia, Crimea, Asia Minor, Palestine, Cyprus, Egypt, Cyrenaica, Tunis, Algeria), throughout the Sudan (as far as Northern Nigeria), in East and South Africa (Eritrea, Kenya Colony, Tanganyika Territory, Zanzibar, Transvaal, Cape Province, Southwest Africa), Transcaspia, Turkestan, Persia, India, Ceylon, China, Korea, and Japan. It has also been found in Bukowina, Hungary and Poland; and there is one record from Germany (Berlin), where the insect was certainly an accidental introduction. It has never been reported from the Malay Archipelago, and it appears to be absent from the West African Subregion. There is, as yet, no record from within the boundaries of the Belgian Congo, although I should expect it to occur in Upper Katanga.

I have seen a specimen of *H. capensis*, from the Canadian National Collection, labelled Okanogan Falls, British Columbia, May 20, 1913 (E. M. Anderson), without indication of a host.

HOSTS.—*H. capensis* was most probably originally a parasite of wild Carnivora in East and South Africa and in the Oriental Region. There are positive records of its having been found in the wild state, in East Africa, on lion, *Felis leo* Linnæus; striped and spotted hyena, *Hyæna hyæna* (Linnæus) and *Crocuta crocuta* (Erxleben); leopard, *Felis pardus* Linnæus; cheetah, *Acinonyx jubatus* (Schreber); civet cat, *Civettictis civetta* (Schreber); serval, *Felis capensis* Forster; and fox, *Vulpes vulpes* (Linnæus). Unfortunately there appears to be no record from any of the Indian wild Carnivora. It is nowadays most commonly found on domestic dogs, especially on the pariah dogs of India, which are said to be fairly swarming with "louse-flies." It has also been taken occasionally on some of the smaller antelopes, such as the duiker, *Cephalophus grimmia*

(Linnæus) (according to A. Loveridge, 1923, Proc. Zool. Soc. London, p. 734), and the dikdik, *Rhynchotragus kirkii cavendishi* (Thomas) (according to Speiser, 1915, Ark. f. Zool., IX, No. 13, p. 3). Waterston (1918, Bull. Ent. Res., IX, p. 155) mentions having taken it on a mule. Very rarely it strays to man, but I have not found any evidence that it actually bites human beings. Giglioli's record of "*O. chinensis*" from a bird (*Turdus obscurus*) seems rather open to question. Speiser (1905, Zeitschr. Syst. Hym. Dipt., V, p. 349), who examined Giglioli's type, found that his *O. chinensis* was a *H. capensis*.

The innumerable races of domestic dogs are certainly of polyphyletic origin. C. Keller (1902) traces them to at least six wild species of jackals and wolves. The pariah dog of Northern Africa and Southern Asia he derives from the common jackal of those regions, *Canis aureus* Linnæus, which quite possibly may have been one of the original hosts of *H. capensis*, from which the insect passed onto the pariah dog.

AFFINITIES.—These have been discussed under *H. equina.*

3. **Hippobosca fulva** Austen

Hippobosca fulva Austen, 1912, Bull. Ent. Res., III, p. 417 [♀; off hartebeest, *Alcelaphus lichtensteini* (Peters); Nawalia, Northeastern Rhodesia].

H. fulva is known only from the type-locality. To judge from Austen's description, it appears to be closely related to *H. capensis*, with which it agrees in size (wing 5 mm. long) and in the pale straw-yellow scutellum. The remainder of the thorax, however, is deep tawny and devoid of markings, while the veins of the wing are uniformly ochraceous. The main structural difference seems to be found in the venation: "third longitudinal vein straight and much closer to second longitudinal vein and costa than in case of *H. capensis* v. Olfers, so that the submarginal cell is conspicuously narrower than in the species mentioned."

4. **Hippobosca maculata** Leach

Hippobosca maculata Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 7, Pl. XXVI, figs. 11-13 (no sex given; East Indies). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 173, Pl. XIII, fig. 99 (♀). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 36, figs. I-V; Pl. IV, figs. 1-2 (♀ ♂, larva, puparium and biology).

Hippobosca variegata Wiedemann, 1830, "Aussereurop. Zweifl. Ins.," II, p. 603 (no sex given; Bengal and Tranquebar).

Hippobosca bipartita Macquart, 1842, Mém. Soc. Sci. Lille, p. 432; 1843, "Dipt. Exot.," II, 3, p. 275 (no sex given; Pondichéry, India).

Hippobosca egyptiaca Macquart, 1842, Mém. Soc. Sci. Lille, p. 431, Pl. XXXVI, fig. 5; 1843, "Dipt. Exot.," II, 3, p. 274 (♂; Egypt) [also spelled *aegyptiaca,* p. 274; and *oegyptiaca,* in Explanation of Plates, p. 294].

Hippobosca fossulata Macquart, 1842, Mém. Soc. Sci. Lille, p. 433; 1843, "Dipt. Exot.," II, 3, p. 276 (no sex given; Brazil or Chile). Speiser, 1904, Ann. Mus. Civ. Genova, XLI, p. 333.

Hippobosca sudanica Bigot, 1884, Ann. Soc. Ent. France, (6) IV, Bull. Séances, p. lix (♀; off horses; eastern Sudan).

Hippobosca sivæ Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 235 (no sex given; East Indies).

Hippobosca calopsis Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 236 (no sex given; Ceylon).

Hippobosca aegyptiaca var. *bengalensis* Ormerod, 1895, The Veterinary Record (August); 1896, Indian Mus. Notes, IV, 2, p. 80 (no sex given; off horses; Bengal).

SPECIMENS EXAMINED.—Uganda: Turkana, Morongole, Northeastern district (Dr. H. Owen). Belgian Congo: Loka, off cattle, May 9, 1909 (Bovone). French West

Africa: Upper Volta River, off horse (E. Roubaud). Abyssinia: Darai, Harar Province (Barnum Brown). Zanzibar: (W. M. Aders). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Mauritius (D. de Charmoy). Madagascar: Tananarive (Lamberton); Mandritsara (F. R. Wulsin). India: Sohawa, Shilum (H. E. Cross); Calcutta. Southern Arabia: Aden, common on oxen, May 9, 1927 (J. Bequaert). Philippines: Alabang (M. B. Mitzmain).

DISTRIBUTION.—*H. maculata* is at present found over a very large area, but much of this is undoubtedly due to accidental introduction by man. In the Oriental Region, it is known from Persia, India, Ceylon, the Sunda Islands, and the Philippines. It also occurs in Arabia. In Africa it is very widely distributed, although much more common in the eastern parts than in the West and the South. There are records from Egypt, the Anglo-Egyptian Sudan, Eritrea, Abyssinia, the French Sudan, Sierra Leone, French Guinea, the Gold Coast, Northern and Southern Nigeria, northern Cameroon, French Equatorial Africa, Uganda, the Belgian Congo, Kenya Colony, Somaliland, Zanzibar, Portuguese East Africa, Transvaal, Madagascar, Mauritius and the Seychelles. It has not been reported from northwestern Africa nor from south of the Orange River, so that it appears to be mainly a tropical insect.

HOSTS.—Nowadays *H. maculata* occurs most commonly on domestic cattle and equines (horses, donkeys and mules), sometimes also on camels. There are no reliable records of its having been found on wild animals. The specimens taken by Neave in the Luangwa Valley, Rhodesia, off a waterbuck, *Kobus ellipsiprymnus* Ogilby, and which he listed as *H. maculata* (1911, Bull. Ent. Res., I, 4, p. 313), were evidently part of the material on which *H. hirsuta* Austen was based. According to Austen (1909) *H. maculata* occasionally bites man.

The decided preference of *H. maculata* for cattle makes it extremely probable that it was originally a specific parasite of one of the wild ancestors of this domestic animal. The origin of the domestic races of cattle has given rise to endless discussions. The most sensible view appears to be that expressed by C. Keller (1902), who admits two ancestors. The usual, larger type of cattle, now prevalent in Europe and America, was derived most likely from a wild species of Central Europe, the urus or "Ur," *Bos primigenius* Bojanus, which survived in the feral state until the beginning of the seventeenth century of our era. The more stubby, zebu type, usually kept in Eastern Africa, Southern Asia and Malaysia, had probably as ancestor the banteng, *Bos sondaicus* Schlegel and Muller, of the Oriental Region, still living in the wild state in some of the islands of the Malay Archipelago. The distribution of *H. maculata* corresponds surprisingly well with that of the zebu type of domestic cattle, so that one may suppose that the insect was originally an ectoparasite of the wild banteng. It would be of great interest to discover the fly on *Bos sondaicus* in the wild state.

It must be mentioned that no hippoboscid flies have ever been found on the water buffalo of Southern Asia nor on any of the African wild buffaloes. These animals are only remotely related to the domestic races of cattle.

AFFINITIES.—*H. maculata, H. rufipes* and *H. hirsuta* form a group of closely allied species, which differ from all the other members of the genus in having a row of setæ on the base of the third longitudinal vein and only one well-developed pulvillus. They also agree in most other peculiarities, except those mentioned in the key. The differences which separate them may appear slight, yet they are undoubtedly of specific value. I suspect that, before man contributed to extend their geographic and host range, every one of these species was confined to a rather small territory and to one or a few related hosts. *H. maculata* was probably then a parasite of wild cattle in the Oriental Region. *H. rufipes* lived on the wild equines of South Africa. *H. hirsuta* was restricted to the large antelopes of tropical Africa, as it is even nowadays.

H. maculata is rather variable in color, so that it has been fair game to the "splitters," as may be seen from the above list of synonyms. I hardly believe that any of these names are worth retaining, even for varieties, and certainly none of them represent geographical races. Speiser (1900, Ann. Mus. Civ. Genova, XL, p. 560) states that in typical *H. maculata* the ground color of the thorax is black, while in the var. *aegyptiaca* Macquart it is reddish brown. It remains to be shown whether the reddish and black forms are geographically segregated. If they occur together, they may well be due to the age of the specimens, or even to their state of preservation.

I cannot regard *H. fossulata* Macquart as anything but a slight variation of *H. maculata.* Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 333) claims to have recognized *fossulata* in a specimen at the Vienna Museum, supposedly taken by Thorey in Surinam in 1859. This specimen differed from typical *H. maculata* only in having a chestnut-brown (not black) thorax, the three spots of the scutum mesonoti not connected, and the fore and middle legs with only the apex of the femora and two rings of the tibiæ brownish black. These variations, however, are readily matched in a series of *H. maculata.* Macquart was uncertain about the locality of his specimen. If the specimen seen by Speiser actually came from Surinam, it must have been introduced there with cattle from the Old World.

5. **Hippobosca rufipes** v. Olfers

Hippobosca rufipes v. Olfers, 1816, "De Vegetativis et Animatis Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen; type said to have been found on an ostrich at the Cape of Good Hope, by Lichtenstein). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 176, Pl. XIII, fig. 100 (♀).

Hippobosca albo-maculata Macquart, 1855, "Dipt. Exot.," Suppl. V, p. 128 (no sex given: "de l'Océanie, Cap des Aiguilles"; like the other Diptera described by Macquart in 1855 as coming from the "Cap des Aiguilles," this insect was obtained at Cape Aguilhas, South Africa).

Hippobosca albonotata Rondani, 1863, Arch. Zool. Anat. Fisiol., Modena, III, 1, p. 92 (no sex given; Caffraria).

Hippobosca maculata Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638 (no sex given; Cape of Good Hope). Not *H. maculata* Leach.

Hippobosca wahlenbergiana Jaennicke, 1867, Abh. Senckenberg. Naturf. Ges., VI, p. 406, Pl. XLIV, fig. 13 (♀; Caffraria).

Hippobosca marginata "Macquart" van der Wulp, 1894, Tijdschr. v. Entom., XXXVII, Versl., p. lxvi (as a synonym of *H. rufipes* v. Olfers).

Hippobosca camelopardalis Roubaud, 1925, Bull. Soc. Path. Exot., Paris, XVIII, p. 466, fig. 1 (♀; off giraffe; between Tabora and Tibu, Tanganyika Territory).

SPECIMENS EXAMINED.—Belgian Congo: Boma, off a mule (J. Rodhain); Uele District (J. Rodhain); Matadi (J. Ghesquière); Elisabethville, off mules imported from South Africa, June 26, 1912 (J. Bequaert); Biano Plateau, July 11, 1923 (Nockermans); Kapiri, July, 1912 (Leplae). Tanganyika Territory: 25 miles east of Ikoma, off eland, *Taurotragus oryx pattersonianus* Lydekker (J. P. Chapin). Southwest Africa: Walfish Bay (Michael Bequaert); Aroab (W. S. Brooks); Windhoek. Cape Province: Windsorton, off cattle (H. Brauns); Kimberley (C. P. Lounsbury). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Orange Free State: Jacobsdal (M. C. Mossol). Transvaal: Pretoria (R. Van Saceghem).

DISTRIBUTION.—This species was originally a South African insect, being now very common in the Cape Province, Basutoland, Southwest Africa, Orange Free State, Transvaal, Bechuanaland, and Natal. It is also found in Zululand and Southern Rhodesia. Its extension northward into Tanganyika Territory and the Belgian Congo may have been partly due to man. Wellman (1908, Bull. Soc. Ent. France, p. 77) has reported it from Benguella (Bihé and Chiyaka), and Austen (1909) from Angola (Bembe Mines, 7° 22′ S.). Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1141) has listed it from the Congo. In recent years it seems to be spreading rapidly beyond its original area.

HOSTS.—*H. rufipes* is nowadays primarily an ectoparasite of domestic equines (horses, mules, and donkeys). Although the type was said to have been obtained off an ostrich, it is more probable that the original host was one of the South African wild equines, *Hippotigris quagga* (Gmelin) or *H. zebra* (Linnæus), both of them formerly common in Cape Colony. There is, however, no record of hippoboscids having ever been taken on these animals. *H. rufipes* is also found at times on cattle and will occasionally settle on dogs or on man. Bedford (1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782) mentions having taken it on the blue wildebeest, *Connochoetes taurinus* (Burchell), in the Northern Transvaal. The finding of this parasite on the East African eland, by Dr. J. P. Chapin, is also of special interest.

H. camelopardalis Roubaud was taken on giraffe, *Giraffa camelopardalis* (Linnæus), in Tanganyika Territory, by my friend, Dr. J. Rodhain. It appears to be identical with *H. rufipes*, to judge from the excellent figure and the brief description; the latter, however, does not mention any of the morphological characters here used to separate the species of Hippobosca.

It was believed at one time by Sir Arnold Theiler that *H. rufipes*, as well as *H. maculata* Leach, were the carriers of a trypanosome (*T. theileri*) found in the blood of cattle in the Transvaal. But the possibility of infection from other sources was not excluded in Theiler's experiments. Moreover, *Trypanosoma theileri* is found all over the world, even in regions where cattle never are infested with hippoboscids, so that the role of these flies as transmitters is most improbable. Nöller's recent work seems to indicate that certain tabanids are the normal carriers of *T. theileri*.

AFFINITIES.—These have been discussed under *H. maculata*.

6. **Hippobosca hirsuta** Austen

Hippobosca hirsuta Austen, 1911, Bull. Ent. Res., II, p. 169, fig. 1*a* (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; Mohokya, Toro Plains and northeast shore of

Lake Ruisamba; both localities in Uganda). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311 and 322. Kinghorn, Yorke and Lloyd, 1913, Ann. Trop. Med. Paras., VII, p. 297.

Hippobosca hirsuta var. *neavei* Austen, 1911, Bull. Ent. Res., II, p. 171, fig. 1*b* (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; junction of the Mpamadzi and Luangwa Rivers, Upper Luangwa River, and Mid Luangwa River; all in Northeastern Rhodesia). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311, 314 and 315.

SPECIMENS EXAMINED.—Belgian Congo: Rutshuru Plains, off waterbuck, *Kobus defassa* Rüppell, March 24, 1927 (H. Coolidge and C. Whitman); Western shore of Lake Edward, off the same host (H. Leboutte); Aka, Uele District, off the same host (J. Rodhain).

DISTRIBUTION.—This species is known from Uganda and the adjoining northeastern regions of the Belgian Congo. The var. *neavei* occurs in Northeastern Rhodesia and Nyasaland.

HOSTS.—*H. hirsuta* seems to be a specific parasite of waterbucks and allied antelopes. The host list includes, at present, *Kobus defassa* Rüppell, *Kobus ellipsiprymnus* Ogilby and *Adenota vardoni* (Livingstone).

Austen's var. *neavei* differs from the typical form only in the shape of the median, straw-yellow spot of the scutellum, which is small and more or less triangular, with apex of triangle resting on hind margin; instead of being large, rounded in front and flattened behind. In the few specimens which I have seen, the spot of the scutellum is of the typical form.

AFFINITIES.—These have been discussed under *H. maculata.*

7. **Hippobosca struthionis** O. E. Janson

Hippobosca struthionis O. E. Janson, in E. Ormerod, 1889, "Notes and Descriptions of a few Injurious Farm and Fruit Insects of South Africa," p. 56, fig. 23 (no sex given; off ostriches; Mt. Steward, Cape Province, South Africa). Ormerod, 1890, Agri, Jl., Cape Town, II, p. 293. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 259 (♀ ♂); 1909, "Illustr. African Blood-Suck. Flies," p. 171, Pl. XIII, fig. 98 (♀). Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 1, p. 5. S. A. Neave, 1912, Bull, Ent. Res., III, pp. 311, 317, and 320. Bedford, 1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782.

Hippobosca struthionis var. *massaica* Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 3, p. 30 (off *Struthio camelus massaicus* Neumann; Tanganyika Territory near Mt. Kilimanjaro).

SPECIMENS EXAMINED.—Cape Province: many specimens without definite locality (C. P. Lounsbury); Willowmore, numerous specimens off ostriches, *Struthio camelus australis* Gurney (H. Brauns). Southwest Africa: Aroab (W. S. Brooks).

DISTRIBUTION.—*H. struthionis* has been recorded from the Cape Province of South Africa, Transvaal, Tanganyika Territory, and Kenya Colony. It probably occurs over the entire range of *Struthio camelus* Linnæus, which nowadays extends over the Arabian-Syrian desert, the Sudan, and parts of East and South Africa (see Reichenow, 1900, Die Vögel Afrikas, I, pp. 5-13). Even within historic times, however, this bird was more widely distributed in Africa than at present. In former geologic periods, the Struthionidæ covered also much of Central Asia and Southern Europe, as shown by fossil remains.

HOSTS.—This fly is a strictly specific parasite of the ostrich, all the living forms or races of which are now regarded as belonging to a single species. The parasite is unusually abundant on its host in South Africa.

AFFINITIES.—In many particulars *H. struthionis* occupies an isolated position in the genus and it is probably not related in any way to the other living species. In general appearance it is more like the usual bird hippoboscid flies than like the other Hippoboscæ. The legs are unusually long and slender, and the empodium is unique.

8. **Hippobosca camelina** Leach

Hippobosca camelina Leach, 1817, "Gen. Spec. Eproboscí. Ins.," p. 10, Pl. XXVII, figs. 11-14 [called *Hippobosca cameli* in the Explanation of Plates, p. 20] (no sex given; Egypt). Dufour, 1858, Ann. Soc. Ent. France, (3) VI, Bull. Séances, p. ciii (described as a new species, from Southern Algeria). Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 257. Theobald, 1906, 2d Rept. Wellcome Res. Labor. Khartoum, p. 92, figs. 48, 50, and 53; Pl. X, fig. 2.

Hippobosca bactriana Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 165 (no sex given; Persia and Massaua, Eritrea).

Hippobosca dromedarina Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176 (new name for the North African parasite of dromedaries, which Rondani called *H. camelina*).

SPECIMENS EXAMINED.—Palestine: Petra (W. M. Mann). Arabia: Akaba, off camel (W. M. Mann); Aden, off *Camelus dromedarius* Linnæus, May 9, 1927 (J. Bequaert). Somaliland: Berbera (A. D. Smith). Kenya Colony: Archers Post, Northern Guaso Nyero River, November 3, 1911 (R. B. Woosnam). Egypt: Lisht (A. Hrdlicka). Tunis: Djerba (A. Weiss).

DISTRIBUTION.—This parasite is found throughout North Africa, Egypt, Syria, Palestine, Asia Minor, Persia, Afghanistan, Arabia, the Sudan (as far west as Mauretania and the Senegal), and northeastern Africa (as far south as Kenya Colony). All of this territory is probably part of its original distribution. It has been introduced recently by man into Southwest Africa. Massonat (1909, Ann. Université Lyon, N. S. CXXVIII, p. 248) mentions a specimen of *H. camelina* collected off a horse in the Camargue, Southern France, the only record of the species, so far as I know, from the European shore of the Mediterranean.

HOSTS.—*H. camelina* is the specific parasite of the two-humped camel, *Camelus bactrianus* Linnæus, and of the one-humped dromedary, *Camelus dromedarius* Linnæus, which are now generally regarded as two domestic races of one single species. The ancestral form is found even now in the wild state in some of the deserts of Central Asia (Gobi, River Ob; western Mongolia). This wild ancestor had formerly a much wider distribution (see Keller, 1902).

AFFINITIES.—*H. camelina* is not closely allied to any other species of Hippobosca. The two pairs of vertical bristles and the complete abortion of the pulvilli are aberrant features not found elsewhere in the genus.

Rondani (1878) and Speiser (1902) have attempted to draw a specific distinction between the flies found on the camel and those from the dromedary, the supposed differences being entirely based upon color characters. After examining many specimens from different localities, I have reached the same conclusion as Austen (1903), that these two forms cannot be separated even as varieties. In coloration *H. camelina* is very variable, even in a lot taken from the same host in one locality. The variation affects the markings of the thorax, as well as the color of the hair on the fronto-clypeus and at the tip of the abdomen. Moreover, since the camel and the dromedary are only races obtained in domestication from a common ancestor, one could hardly expect specific or sub-specific differences in their parasites.

REARING THE LARVÆ OF *DERMATOBIA HOMINIS* LINN., IN MAN

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The following article presents some observations on the development of the larvæ of *Dermatobia hominis* when reared in man, and on the effects of an infestation of these larvæ upon the host. The results of studies on other phases of the interesting life-history and habits of this species of parasitic diptera will be presented in later reports.

In October, 1929, while seated at the edge of a small stream near Summit, Canal Zone, I captured a fly which was hovering about and which had several times alighted on my right knee. This fly proved to be a species of *Limnophora,* not a blood-sucker, and a number of eggs were found attached to her abdomen. An examination of these showed them to be eggs of *Dermatobia hominis.* Many of them had developed to the larval stage, the operculum at the hatching end being open and the minute larva inside of each being active and ready to leave its shell when a suitable host was provided.

Through the acquiring of these eggs a good opportunity was afforded for studying the development of the larval stage of *D. hominis* with man as the host, and in view of this it was decided to allow two of the larvæ to enter the skin of my arm.

October 9. At 4 P. M., about six hours after capturing the egg-bearing fly, the glass tube in which it was confined was unstoppered and inverted on the skin of my left forearm. The tube, which was about four inches long and one inch in diameter, allowed room for considerable movement on the part of the fly. The latter was quite active and would not rest on the skin except very momentarily, but kept up a continual dashing about in the tube. The larvæ were all protruding from the egg shells, but the swift movements of the fly seemed to prevent them from remaining on the skin for a sufficient length of time to allow them to crawl from the shells. This continued for about five minutes, and it was then noticed, with the aid of a hand lens, that as the fly dashed against the side of the tube one of the larvæ was left hanging to the glass. About one minute later this was repeated and a second larva was left crawling about on the inside of the tube. The fly was then removed and the two small larvæ inside the tube were picked up on the point of a needle and gently placed on my left forearm at about the upper third of the median flexor region. Since there were no abrasions of the skin at this area, an opportunity was given for observing the entrance of the larvæ into unbroken skin.

The two larvæ were placed in the skin slightly less than an inch apart, and each remained at exactly the site where it was placed. Neither of them could be detected as having moved even a quarter of an inch. They remained so motionless that at first it was feared that they had been injured by the needle in transferring them from the tube to my arm. After watching them closely with a 10 X lens for a few minutes, however, a few faint contractions could be seen, and it was also noted that the anterior, or larger, end of each larva seemed to be sinking very slowly into the skin. This large end of each larva seemed to be about one-third, horizontally, pressed into the skin, and was evidently securing traction through the use of the oral hooks and dermal spines, while the posterior end exerted a progressive forward motion. The larvæ were lying nearly parallel with the skin, and with but a slight arching near the posterior end, so that their position in relation to the skin surface was thus very oblique, and the penetration was at first beneath just the outer part of the skin.

One of the larvæ had practically all of its large anterior part imbedded in the skin in about thirty minutes. It was then able to obtain sufficient purchase with its spines, so that rapid progress was made and the posterior end was soon inside. At the end of 42 minutes from the time this larva was placed on my arm it was completely out of sight in the skin and could not be seen even with the aid of a lens. There was absolutely no sensation caused by the entrance of this larva until after the first thirty minutes. Then, as the posterior end was being drawn inside, a sharp pricking, which lasted for about two minutes, was experienced.

The second larva was much slower in effecting an entrance and required an hour and thirty-five minutes to bury itself completely in the skin. At the end of an hour approximately half of the anterior end was inside. At this time I rolled down my shirt sleeve and put on my coat to determine if the rubbing of clothing would loosen the larva or have any apparent effect upon its entrance. After spending about thirty minutes in walking about and in doing some work in the laboratory which necessitated using my arm rather actively, I removed my coat and inspected the larva. At this time it was all buried in the skin with the exception of the tip of the posterior end, and five minutes later that also was inside.

During the night following the entrance of these two larvæ into my skin a marked itching and pricking sensation at the sites of their location was experenced at intervals. Although this did not last more than half a minute at each time it occurred, it was sharp enough to awaken me several times during the night.

October 10. Fourteen hours after the entrance of the larvæ it would have been nearly impossible to locate them. Since I had ringed the sites with ink, however, and thus knew their exact situations, they could with the aid of a lens be detected as pinpoint raised areas which were slightly reddish. After twenty-four hours they were visible to the naked eye as slightly elevated tiny red dots. When viewed closely with the lens the tiny posterior ends of the larvæ could be detected slowing moving up and down in a pumping movement and forcing out minute quantities of fluid.

October 11. This evening a sharp itching was felt at two small pimples which were at first thought to be caused by mosquito bites. One of these was located at the midulnar margin of my right arm, approximately four and a half inches from the wrist joint. The other was on the internal surface of my right thigh about midway between the knee and perineum. When these were rubbed there seemed to be more soreness present than usually accompanies mosquito bites. My suspicions becoming aroused, a closer examination was made, and it was then found that each of the small lesions contained a larva of *D. hominis*. A further search showed two more of the larvæ infesting me. One of these was on the flexor side of my right wrist and the other on my right shin, about two inches below the lower margin of the patella. I had felt nothing which might indicate the presence of these last two larvæ, and it was only the tiny red pimples caused by them that revealed their presence to the naked eye. Apparently it had been just a case of carrying coals to

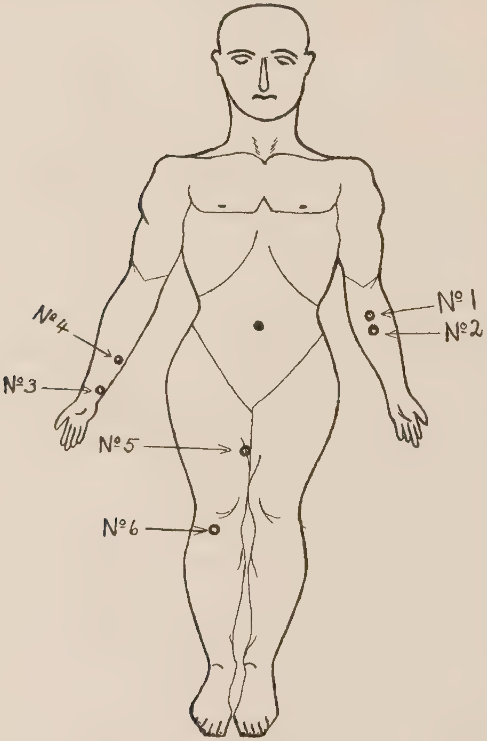


FIG. 1.—Diagram showing locations of the larvæ.

Newcastle when I allowed the two larvæ to enter my left arm, since I evidently was already infested with four of them at the time. It is quite certain that these four larvæ were deposited on me by the carrier fly while it was alighting on me just prior to its capture. This placed their entrance into my skin at about six hours earlier than when the two entered my left arm. Finding myself now infested with six of the larvæ I decided to allow them all to remain until they began to produce too great a reaction, either local or general. In order to record observations on the larvæ each one was given a number. The two on the left arm were numbered 1 and 2; the one at the right wrist was No. 3, in the right forearm No. 4, in the upper right leg No. 5, and below the right knee as No. 6. Nos. 1, 2, 4 and 5 were located in areas surrounded by considerable adipose and muscular tissues, while Nos. 3 and 5 were in situations surrounded mainly by fibrous tissue and with much less softer tissues.

October 16. Each lesion, or site of each larva, now appears as a bright red area, about three-eighths of an inch in diameter, and slightly elevated in the center. There is sufficient itching and pricking occurring to cause considerable discomfort. The irritation seems to be much greater during the evenings and nights than throughout the days. No. 6 proves an exception to this, since there is frequently a prolonged stinging or burning sensation experienced when I am walking. While I am at rest this larva seldom causes any annoyance. No. 4 seems to be causing the greatest irritation. This may be due to the location of this lesion on the lower surface of my right forearm, and thus subjected to considerable rubbing on desk and tables while I am at work.

October 17. Last night I was awakened by a severe itching and dull burning sensation at No. 4. The burning sensation seemed to feel more like an erosive burn caused by a strong acid than to contact with a hot surface. All the lesions are exuding serous fluid at times. That which comes from Nos. 1 and 4 is slightly tinged with blood.

October 18. Last night the lesions on both arms became very irritating and awakened me several times. There has also been considerable itching and pain today.

October 20. Yesterday and today there has been but little discomfort. The lesions now have the appearance of small boils. They are a deep red in color, swollen and with some induration of the surrounding area. The indurated area surrounding No. 4 is about an inch and a half in extent.

October 21. A severe stinging pain is occurring at intervals at Nos. 1 and 2 on my left arm. These two lesions are so close together that it is difficult to determine whether it is only one or both that cause the pain. There is also a severe itching at No. 5 and an occasional sharp, stabbing pain in No. 6.

October 22. During the night I was awakened several times by sharp stinging pain in Nos. 1 and 2. There was intense itching in No. 3 and on two occasions when I awakened during the night I found that apparently I had been scratching this lesion while still asleep. This morning a considerable area of the ulnar surface of my wrist was greatly swollen and an intense itching occurs when the skin is touched, even though it be at some distance from the lesion.

October 24. The lesions have increased in size and have more of the appearance of small boils which have "pointed" and erupted slightly. There is considerable oozing of serous fluid, blood-stained pus and dark-colored matter which I believe is digested blood being defecated by the larvæ. The exudate from the lesions is now sufficient to be quite disagreeable, owing to its staining clothing and bedding, and it is necessary to bandage all the lesions. It is to be regretted that the bandages were not applied earlier, so that the date of possibly a first molt of the larvæ might have been noted. It is my opinion that this molt occurred about October 21, and that the small amount of discomfort present on October 19 and 20 was due to the larvæ being in the first pre-molting period at this time and were not feeding and were quite inactive. Had the bandages been on the lesions at the time it is possible that some traces of the molted skins might have been found which would denote the time of the molt.

October 26. There seem to be three kinds of local sensations connected with the presence of the larvæ. The first of these is an intense itching of the skin of the area surrounding a lesion. This may be due to an infiltration of the tissues with the fæces of the larva and other fluids present in the lesions causing a slight cellulitis. This itching was not constant but occurred at frequent intervals, and is induced by even very slight friction in the vicinity of the lesion. The second sensation is a very irritating pricking which takes place in the lesion. This is probably caused by the rasping of the cutaneous spines or hooks on the larva during any movement of the latter. The third sensation is a sharp, stinging pain, which is believed to be produced by the tearing of the tissues by the oral hooks of the larva when it becomes necessary to use the hooks in order to excite the flow of serum or blood to serve as food.

October 29. Nos. 3 and 6 are now much more swollen than are the other four lesions which are located in areas of more adipose and muscular tissues. The four located in more favorable situations are but little swollen on the outside, but can be felt as hard nodules, each as large as a good-sized marble and seeming to extend into the subcutaneous tissues. During the past three days there has been less of the pricking sensation occurring. This may be due to the lesions becoming walled off so that each larva is to some extent encapsulated. Or, again, it may be due to wearing bandages over the lesions. When the latter were exposed to the air the exudate soon dried and formed small scabs that at times seemed to seal over the small openings of the lesions, and it is quite plausible to believe that in order to burst through these scabs some struggles were required on the part of the larvæ when it was necessary for them to take air or discharge fæcal matter. With the lesions bandaged the exudate is being continually absorbed and the holes left open and moist around the edge. A quite pronounced vesicular eruption has now appeared on both hands and wrists and on my right leg. This is accompanied by an intense itching and a slight oozing of serum from the vesicles.

October 31. During yesterday and today there have been several attacks of excruciating pain experienced from Nos. 3 and 4. This pain was possibly a nerve irritation caused by the oral hooks of the larvæ tearing the tissues. These attacks lasted from one to three minutes each time they occurred. Squeezing the arm just below the lesions seemed to stop the pains to some extent. These two lesions bled sufficiently to stain through the bandages several times today.

November 3. Drops of apparently unchanged blood oozes at intervals from Nos. 1 and 3 when the bandages are removed. Blood-stained serum is exuding from Nos. 2, 4 and 5. No pus is in evidence except a small amount from No. 6. When viewed with a lens at this time each larva may be seen pushing liquid from the hole with a quick, pushing, upward movement somewhat after the action of a plunger of a pump. The downward movement seems to draw back some of the fluid with each jerking back of the posterior end of the larva. When the end of a larva is retracted an occasional air bubble can be noticed coming up through the liquid. There has been very little pain or irritation caused by any of the lesions today.

November 4. A sharp pricking lasting several minutes has occurred at intervals during the day and early evening in No. 6. This lesion and the area surrounding it is quite red, considerably swollen and very sore to the touch. At about seven o'clock this evening when the bandages were removed for a while this larva was found to be pushing out a cast skin. The larva had molted, and since it probably needed more room in the hole for its future growth, was disposing of the cast skin. The movements of the larva caused the skin to emerge in its natural, round, tube-like form. As it came slowly out it formed a tiny crater about 2 mm. high around the hole and then continued to turn back upon itself with the posterior end of the larva pushing up through the center. From the manner in which the molted skin moved slightly from side to side it appeared as though the larva was pushing it up first at one side and then at the other, but keeping it about even so that the rows of hooks of each segment were all out before those of the next segment appeared. After observing the efforts of the larva with a hand lens for about three hours, it was estimated that about one-third of the cast skin was still in the hole. None of the other five lesions have caused very much discomfort.

November 5. This morning the molted skin from No. 6 was found all outside of, and still surrounding, the hole. This larva was quite active and caused considerable irritation during the day. None of the other five lesions caused much discomfort. The fluid is exuding in a smaller amount than usual, and it seems to be comparatively clear serum with the exception of that which is coming from Nos. 1 and 5, which is rather heavily tinged with blood. The other five larvæ are probably also preparing to molt.

November 6. The larva in No. 3 molted and ejected the cast skin during the A. M. Following the ejection of the skin, which was found adhering to the bandage, this lesion exuded a considerable amount of blood during the day. Frequent sharp, stinging pains at No. 6. This pain is so severe that at each attack it is necessary to remove the bandage and place a hand on each side of the lesion and press upward in order to stop the action of the larva. There is only a small amount of deep tissue surrounding this lesion and the larva is situated parallel with the surface of the skin.

November 8. Cast larval skins were ejected from Nos. 1, 2 and 4 this P. M. This leaves all the larvæ molted except No. 5. Both arms are now very sore, and sufficient bloom and serum is exuding from the lesions to stain through the bandages soon after they are applied.

November 10. No. 6 has caused excruciating pain at intervals throughout the day. During the evening one attack lasted for fifteen minutes and became almost unbearable. Pressing on the sides of the lesion and allowing cold water to run on it seemed to have but little palliative effect. This attack was followed by bleeding. Blood oozed from the lesion in a thin stream and continued until it had soaked three gauze pads that were applied one after the other. No. 1 also bled sufficiently at one time this evening to stain through the gauze pad, bandage, shirt sleeve and coat sleeve. During the night I awakened to find that this lesion was again bleeding and to the extent of soaking through the dressings and sleeve of my pajamas.

November 11. No. 1 gave the most trouble today. During the afternoon it suddenly developed a severe, deep-seated pain which seemed to extend for some distance up and down my arm. After this pain had lasted for about a minute, bleeding began. From the way in which the blood bubbled from the lesion it appeared as though it came from a small artery. This continued for several minutes until by applying cold compresses to the lesion it was induced to stop.

November 12. The exudate from No. 3 today consists largely of pus with a very fetid odor. Serum mixed with dark-colored digested blood and pus is oozing from No. 4. Several spasms of pain occurred during last night and today in No. 5. This pain was severe enough to awaken me several times during the night. No. 1 again bled profusely on two occasions today. The bleeding started both times soon after the bandage had been removed. The blood welled out in a small stream, and it was necessary to hold my arm beneath running tap water for some time before it ceased. These hemorrhages were sufficiently severe to cause me to consider the advisability of having No. 1 removed in order to prevent the possibility of losing a considerable amount of blood during the night while asleep. I have decided, however, to delay any action and await developments for another day or so. Both times that the bleeding occurred from this lesion it was preceded by a sharp, deep-seated pain which was sufficiently acute to cause a slight nausea.

November 13. The sharp pain and bleeding from No. 1 again occurred this afternoon just after a fresh bandage had been applied. Blood-stained serum is exuding from Nos. 2 and 5. Serum mixed with blood and pus is issuing from No. 5, while pus only is being discharged from No. 3. A cast larval skin was expelled from No. 5 today. All the larvæ have now molted with nine days' difference between the time the molted skin was ejected from No. 6 and No. 5. Both arms are now very sore and a lymphangitis extending almost from the elbow to the axilla of my left arm is evident. The epitrochlear and axillary lymph nodes of the left arm are enlarged to about the size of marbles and are tender to the touch. The nodes of the right arm are also swollen and tender, but not to the same extent as on the left side. A general feeling of lassitude which is quite marked has been experienced during the past few days.

This may be due to absorption of toxins from the lesions and may also be influenced by the many times that I am awakened each night by the larvæ. The lesions are now emitting a fetid odor which becomes very disagreeable if the bandages are not changed frequently. When they remain unchanged during the night the odor is extremely offensive in the morning.

November 14. During the night I was awakened by a severe pain in No. 3 and a contraction of the muscles of the wrist and forearm. This served to draw my hand back on the wrist, and I was unable to straighten the hand except by using my left hand. It was necessary to place the hand and wrist in cold water before relief was afforded. Considerable blood and serum oozed from this lesion following the pain and contraction. During the past few days this lesion has become much swollen and is very red and inflamed. The center of the lesion is taking on a dark purple appearance, although the aperture is well down on one side near the base of the swelling.

November 17. No. 5 is very painful and the muscles of the leg are stiff and sore to the touch, and is causing some lameness. All the lesions are oozing considerable serum and pus. I seemed to be quite feverish at one time when I awakened last night, but the feeling of lassitude was so great that no temperature was taken.

November 19. No. 3 has been causing severe pain and muscular contraction at intervals during the past four days and the wrist is very painful. No. 6 has been quite sore for several days, and this evening it was found that another opening had developed in it. This new opening is located on the side opposite the original opening and about where the anterior end of the larva seems to be. It is a question whether this second aperture is due to action of the oral hooks of the larva or to sloughing caused by pus inside the lesion.

November 20. No. 3 awakened me several times during the night by piercing and nauseating pain. This morning it was found that there were two more openings in this lesion and with serum and pus oozing from each. One of these openings is near the center of the lesion and the other at about where the anterior end of the larva is situated.

The development of this opening in the center of the lesion is evidence that these extra openings are due to ulceration.

November 21. Serum and pus with a very disagreeable odor is exuding from all the lesions at this time. At No. 3 the anal end of the larva is visible in the opening and the stigmal plates may be seen. The larva in No. 6 has been protruding from the opening about a quarter of an inch all day, regardless of whether the bandage is on or not. When the bandage and gauze are in place the protruding end of the larva makes a sort of a small burrow in the gauze pad. Several times during the day the larva twisted about rather vigorously as though it might be about to emerge.

November 22. The larva in No. 6 still remains with its posterior end protruding from the hole the greater part of the time. The pain from this lesion becomes so intense at times that it is almost impossible to walk until the paroxysm is over. These pains (although of frequent occurrence) are, fortunately, of short duration. Blood and serum issues from the new opening after each of these attacks. The larva in No. 3 seems to be enlarging the opening in the lesion today.

November 23. Larva No. 6 is still twisting about quite frequently and causing considerable pain. It continues to have its posterior end outside the hole and burrowed into the dressing during the greater part of the time. The dressings are very loose and would not prevent the larva from emerging. The dressings are removed frequently but the larva makes no attempt to come out any further when they are off. With the exceptions of Nos. 5 and 6 all the larvæ seem to be enlarging the apertures to the lesions. There is considerable discharge of serum, digested blood and pus from No. 5 today. The feeling of lassitude still continues and short spells of slight fever seem to occur at intervals. I am still being awakened many times during the night by the larvæ.

November 24. The posterior end of the larva in No. 2 protruded from the hole about a quarter of an inch this morning. When viewed with a lens the larva could be seen enlarging the hole by means of a rasping movement of the spines on its posterior end. The hole is now about

5 mm. in diameter. The larva looks larger and has a yellowish color. The larva in No. 1 has a reddish tint as though it is still taking blood as food. No. 6 is still protruding the greater part of the time and continues to be very painful. There is considerable discharge from No. 5 and much irritation present.

November 25. Larvæ Nos. 2 and 4 spent considerable time last night in enlarging the openings to the lesions occupied by them and they both emerged this morning. While in the bath taking a shower I noticed larva No. 2 as it came straight up out of the hole and dropped over on my arm. I immediately placed this larva in a test tube, and was about to return to the shower when I saw that No. 4 was protruding from the opening with a slight side to side weaving motion. It slowly and easily continued its emergence until it finally came entirely out with almost a slight spring. There was absolutely no pain or sensation as these two larvæ emerged, and had I not happened to see them as they did come out I should not have known that they were emerging. From the time when larva No. 1 began to enter my arm as a tiny larva until it emerged mature and ready to pupate was 46 days and 15 hours, while the period of infestation with No. 4 was approximately 46 days and 21 hours. These two larvæ emerged within ten minutes of one another. This is probably the first record of the exact time between entrance and emergence of a larva of *Dermatobia hominis.* This afternoon a sharp, stinging pain and much movement was felt in No. 6. The bandage was removed and the larva was found to be protruding somewhat more than it had been previously. During several minutes of observation the larva did not appear to be making any efforts to come out fruther and the bandage was replaced. About fifteen minutes later a movement was felt between the dressing and my skin, and an examination showed that the larva had emerged and after crawling nearly to the edge of the gauze pad was burrowing into the latter. There was no sensation felt with the actual emergence of this larva and it was only the movement of it against my skin that apprised me of the emergence. See Plate 13.

November 26. No. 3 gave numerous twinges of pain during the day and pus continued to ooze at times from the two extra openings in this lesion. There has been very little movement felt at Nos. 1 and 5 today. This evening the bandages were left off for a time and the larvæ were observed with a lens. Both these larvæ could be seen working vigorously enlarging the apertures to the lesions. This was done entirely by the spines on the posterior segments. They were rubbed against the side of the hole with a rasping motion, and this was carried on at first one side of the hole and then the other. It reminded one of enlarging a round hole with a round file. At intervals of from five to ten minutes each of the larvæ protruded from its hole for more than a quarter of an inch as though testing the diameter of the opening to see if it be large enough to permit the emergence of the larger anterior end. After protruding for a few minutes the larva withdrew within the lesion and again began its rasping on the edge of the opening. This continued for about three hours, when the bandages were again applied. There was considerable movement in No. 5 today and the escape of pus and digested blood from this lesion was sufficient to soak through the dressing twice during the day.

November 27. Larvæ Nos. 1 and 3 were quiet and gave very little trouble during the night, but this morning they became active and protruded so far that it was thought that they were about to emerge. No. 3 continued more or less movement during the early morning and the dressing was removed several times to see what was taking place. At each time the larva was partly out of the hole, but it always withdrew again after coming out about so far. At 10 A. M. a movement was felt on my skin at the lesion and upon examination the larva was found to be coming out. It appeared to be doing very little struggling, yet it slowly came from the hole and dropped over on my arm.

November 28. Larva No. 1 seems to be dividing its time between protruding for about half an inch and working very industriously at enlarging the hole, although the latter is now fully 5 mm. in diameter.

November 29. While I was taking a shower this morning, larva No. 1 protruded for nearly half an inch for a few moments, when it again withdrew. Ten minutes later it again began to come out, and this time continued very slowly and steadily to emerge. The emergence covered a period of about one-half hour. The exact infestation period of this larva was 50 days and 15½ hours.

December 3. The last larva, No. 5, has been alternating between enlarging the hole of the lesion and protruding its posterior end during the past four days, until it emerged some time between 12:30 and 6 o'clock this morning. It emerged and crawled outside the bandage without awakening me, and was found in the bed at 6 A. M. It was rather surprising to find that this larva was the smallest of the six. It was expected that since it had been located in an area with an abundance of muscular and adipose tissues together with its longer period in situ, about 54¾ days, that it would be the largest.

A slight exudate continued from the lesions until from three to five days following the emergence of the larvæ. Then as the discharge ceased and the swelling subsided the apertures soon healed.

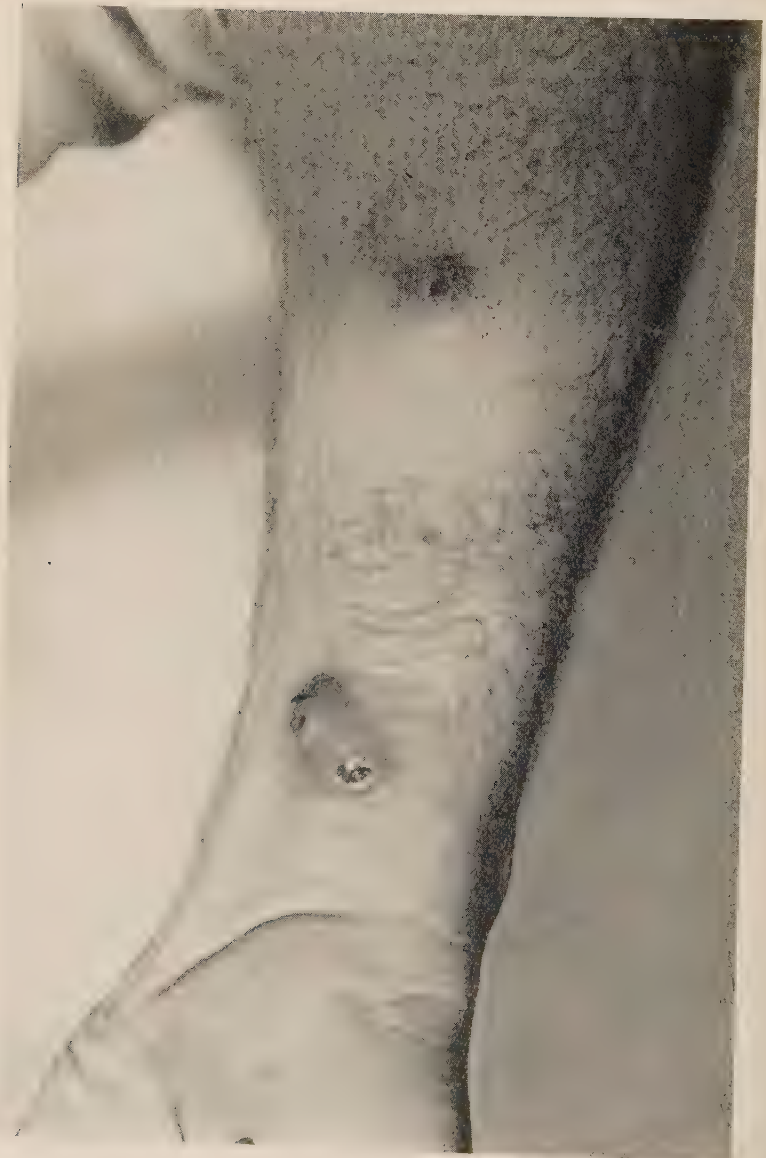
With the exception of No. 6 the scars left by the lesions were very slight ones. Eight months later well-colored purple and brown spots still mark the sites of the two openings of No. 6.

The size and weight, taken within two hours after emergence of each of the larvæ were as follows:

Larva No.	Length	Diameter	Weight
1	22 mm.	10 mm.	0.692 gram.
2	20 mm.	9 mm.	0.575 gram.
3	25 mm.	11 mm.	0.725 gram.
4	24 mm.	11 mm.	0.740 gram.
5	20 mm.	7 mm.	0.480 gram.
6	20 mm.	8 mm.	0.520 gram.

Soon after each larva emerged it was placed in damp sand and sawdust to pupate. The pupation periods were from twenty-two to twenty-four days, at the end of which time the adult flies emerged.

Psyche, 1930 VOL. 37, PLATE 13.



DERMATOBIA HOMINIS

EXPLANATION OF PLATE 13.

Appearance of lesion No. 3 (at wrist) two days before the larva emerged, and of No. 4 eight hours after the larva emerged.

THE LOWER PERMIAN INSECTS OF KANSAS
PART 3. THE PROTOHYMENOPTERA

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The order Protohymenoptera was established by Tillyard (1924) to include a series of fossil wings contained in the Yale collection from the Lower Permian of Kansas. As indicated by the name, Tillyard believed that this group was ancestral to the Hymenoptera and was sufficient to prove that the Hymenoptera originated independently from the rest of the holometabolous insects (1926b). While it is true that certain morphological features of the Hymenoptera, such as the reduced wing venation, and the polynephric Malpighian system, remove the group from the true panorpoid orders; the results of morphological studies (Crampton, 1919, 1927) indicate that the Hymenoptera arose from the same stem as all the other insects with a similar metamorphosis.[1] It is therefore advisable for us to submit any paleontological evidence which seems inconsistent with this view to the carefullest examination.

Aside from phylogenetic consideratons, the question of the affinities of the Protohymenoptera has close bearing on the interpretation of the wing venation in the Hymenoptera; for the specialized condition of the wings in the Hymenoptera has prevented entomologists from satisfactorily homologizing the veins with those of other insects. As a result, a number of different systems of venational

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[1] Handlirsch, however, has held the opposite view (1906-08).

nomenclature are being used in the Hymenoptera, each more or less limited to a certain group of families. Comstock, MacGillivary, and a few others have proposed systems intended to homologize the venation with that of other groups, but hymenopterists in general have not accepted these schemes. More recently Tillyard has advanced a new and radically different system (1924) based on the assumption that the Protohymenoptera exhibit the primitive condition of the venation in the hymenopterous line of descent; and he believes that through this interpretation the whole of the homologies of the veins at once "becomes clear and of the utmost simplicity" (1926c, p. 256).

Let us consider briefly the opinions expressed by other entomologists on the affinities of the Protohymenoptera, and on the new system of venation in the Hymenoptera, based on these fossils. Lameere (1927) accepts the insects as representatives of the group ancestral to the Hymenoptera, and also adopts the venational interpretation, with a few slight modifications. Handlirsch (1927), however, has briefly (without discussion) suggested that the fossils are more closely related to the Megasecoptera than to the Hymenoptera, and may actually belong to that order. Cockerell (1927) appears to accept the fossils as of hymenopterous nature, but suggests some changes in the interpretation of the veins. Crampton (1927) agrees that the fossils are hymenopterous and he favors the venational system.

Martynov has studied the question more thoroughly. In 1928, while collecting insects in the Permian beds (Kazan) of Northwest Russia, he discovered a single wing which resembles both the Kansan Protohymenoptera and certain Carboniferous Megasecoptera. From his study of this fossil and the Kansan specimens in the Yale collection, he concluded that the Protohymenoptera were really close to the Megasecoptera, and not related to the Hymenoptera. "They belong to my subdivision Paleoptera containing all orders, chiefly extinct, in which the wings were outspread when at rest. Indeed, both *Protohymen permianus* Till. and *Permohymen schucherti* Till. were found in the outspread condition of the wings, and even Tillyard thinks

that such a discovery 'suggests very strongly that the insects of this family rested with outspread wings, as did the Palæodictyoptera and Megasecoptera.' It is true that among Asthenohymenidæ specimens 'occur, in which one wing is laid exactly over the other,' but the same takes place in the case of the Zygoptera, and this manner of resting in Zygoptera in no way proves that they are allied to the Hymenoptera or to any other Holometabola or even Neoptera. When an insect of the division Neoptera, for instance a Neuropteron, puts its wings on the dorsum in roof-shaped manner, the upper surface of the wings is exposed upwards and outwards, with costal borders placed beneath, along the support. On the contrary, in Zygoptera, as also in some Agnatha, when at rest the upper surfaces of the wings are turned inwards, with the dorsal borders looking upwards, i. e., the manner of folding the wings at rest is very different in the Zygoptera and in the Neoptera. Perhaps some forms of Protohymenoptera could 'fold' their wings back on the dorsum, but such 'folding,' in all probability, recalled that of the Zygoptera or of the Agnatha, but not of the Hymenoptera or Copeognatha, or in general, of the Neoptera. Further, such facts as that the fore and hind wings in the 'Protohymenoptera' were of almost equal size, had the same wing venation, were not linked together in flight by hooklets, or by any hairs, and had some veins, at least the costa and the radius 'serrated along its outer edge, in exactly the same manner as that in Odonata,' clearly manifests that the whole order belongs to the division Paleoptera and is allied partly to the Megasecoptera, partly to the Odonata and Protodonata. The membrane of the wings was glassy, as in Agnatha or in Megasecoptera or in Odonata. Many Neuroptera, Mecoptera and Hymenoptera and even some Trichoptera have also a glassy membrane, but in these groups the wing membrane is furnished not only with chetoids . . . but also with numerous true hairs. In the wings of the Hymenoptera both chetoids and hairs are present everywhere, though the hairs sometimes become very small, minute. The wing membrane in the Odonata and Agnatha, as well as, probably, in Megasecoptera, is really glassy, i. e., perfectly deprived of both hairs and chetoids. One should suppose

that in the group ancestral to the Hymenoptera we must inevitably find some remains of hairs, similar to those which exist, for example, in the wings of the fossil Mecoptera. Thanks to the kindness of Professor Schuchert . . . I examined the excellent remains of both Protohymen and Permohymen, but I could not perceive any hairs on their wings. The wing of the new genus Aspidohymen from Tikhie Gory also does not show any traces of hairs. Thus, such a character of the wing membrane manifests also that this order is very far removed from the order Hymenoptera, as well as from the remaining Holometabola, and is allied rather to the order Odonata, etc., i. e., belongs to the division Paleoptera." (1930, p. 79.)

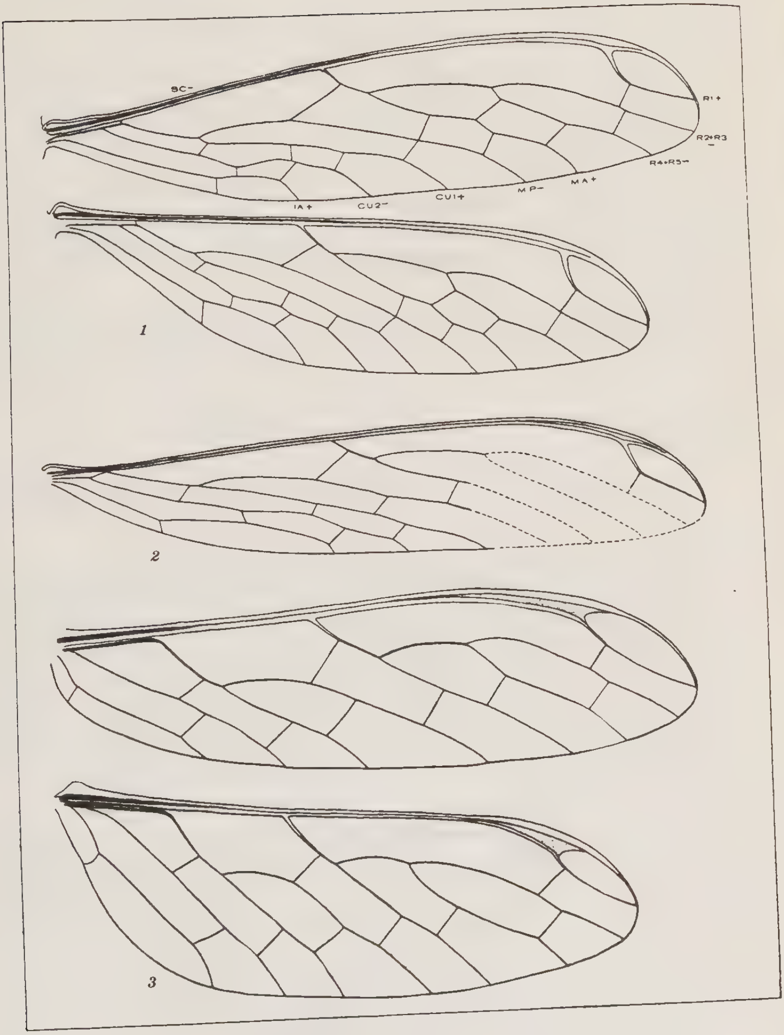
In 1927, one year previous to Martynov's discovery of the Russian specimens, I was fortunate enough to secure fifty-five representatives of the Protohymenoptera in the limestone at Elmo, Kansas. At that time it was already clear that a knowledge of the structure of the body of these insects would help us immensely in determining their affinities. Since the Yale specimens consisted only of wings, the chief aim of our collecting trip was to obtain specimens of Protohymenoptera with the body preserved. In this respect we were most successful; several fossils show portions of the bodies, and one specimen includes nearly the whole body, with the minutest details perfectly preserved. Through the kindness of Professor Dunbar I have been able to examine the twenty-three specimens of Protohymenoptera in the Yale collection, including Tillyard's types; and I have also found four additional fossils in Dr. Sellards' collection. From my study of all these representatives of the group, totaling eighty-two, I am convinced that Handlirsch and Martynov were correct in their assumption that the Protohymenoptera were megasecopterous. The evidence which leads me to this conclusion will be presented after the description of the fossils.

It will be observed in these descriptions that I have employed an interpretation of the venation which differs from that used by Tillyard, as well as from that offered by Martynov. These changes in the nomenclature of the veins are necessary because both of these authors have been mislead by an erroneous conception of the convexities

and concavities of the veins. The evidence for this will also be considered after the descriptions.

The Kansan Protohymenoptera were separated by Tillyard into two families, Protohymenidæ and Asthenohymenidæ, based largely on the degree of development of the pterostigma, the presence or absence of the radial sector, and the relative lengths of the second anal vein. This classification is a convenient one and is used here, but the most striking difference between the families lies in the width of the costal space. The second of the characteristics mentioned by Tillyard must be omitted, for the radial sector is present in all forms. One change in the terminology of the families must be made. In 1906 Sellards described one of the Kansan fossils in his collection as *Doter minor;* this specimen consisted of the thorax, abdomen, two long cerci, and the two front wings, but the latter were so twisted and folded that he was unable to determine satisfactorily the nature of the venation. He was not sure of the taxonomic position of the fossil, but believed that it was related to the Protephemeroidea. Handlirsch (1919) placed it within a separate family, Doteridæ, and doubtfully considered it to be a Paleodictyopteran. When I examined this type specimen in 1927 at Austin, Texas, I observed at once from the nature of the wing membrane and the venation that it belonged to the genus Asthenohymen, which Tillyard had just described. From the photograph, drawings, and notes which I made at that time, I am now able to recognize it as the same species which Tillyard called *A. dunbari,* the commonest of all the Protohymenoptera in the Elmo limestone. Of course this identity is not obvious from Sellards' figure of *Doter minor,* for the distortion of his fossil and the fact that the insect possessed an unusual type of venation prevented Sellards from obtaining a correct idea of the venation. This synonymy requires us to change the name of the genus from Asthenohymen to Doter, and the corresponding family name to Doteridæ. It is interesting to note that Dr. Martynov has observed (1930, p. 85) a similarity between the venation of Doter, as figured by Sellards, and the venation of Asthenohymen, and he has suggested that Doter may be a Protohymenopteron. Dr. Martynov deserves to be con-

Psyche, 1930 VOL. 37, PLATE 15.



Carpenter—Permian Insects.

gratulated on the keenness of his observation and the accuracy of his conclusion.

FAMILY PROTOHYMENIDAE

Fore wing: costal margin very slightly convex, nearly straight; costal space present at very base of wing only; Sc rather long, extending a short distance beyond the origin of Rs; R close to the costal margin, except at the very base; R1 diverging downward distally, away from the pterostigma; pterostigma very slender; Cu straight at base of wing; Cu1 and Cu2 diverging near the base; 9-14 cross-veins.

Hind wing: a little shorter and broader than fore wing, and differently shaped; venation similar.

Protohymen Tillyard

Protohymen Tillyard, Amer. Journ. Sci. (5) 8 (44) : 113, 1924.

Fore wing; very slender, subpetiolate; R remaining in contact with the costa to the pterostigma and joined to the costal margin by a heavy cross-vein distad of the pterostigma; Cu1 diverging backward directly after its origin; 13-14 cross-veins. The positions of the cross-veins, designated by Tillyard as generic features, are subject to great individual variation; but the cross-vein between 1A and the hind margin is always remote from the base of the wing.

Hind wing: more petiolate than fore wing; Cu more remote from R+M at the base than in the fore wing.

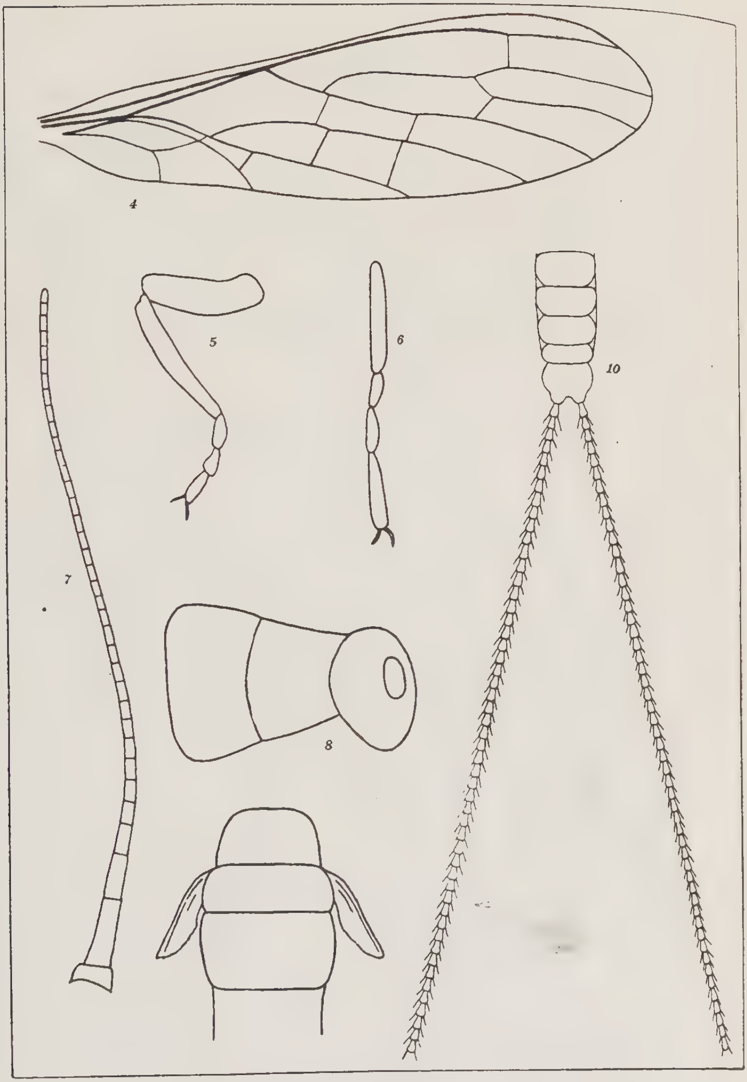
Genotype: *Protohymen permianus* Tillyard.

Protohymen permianus Tillyard

Figs. 1, 11

Protohymen permianus Tillyard, Amer. Journ. Sci. (5) 8 (44) : 114, 1924.

Psyche, 1930 Vol. 37, Plate 16.



Carpenter—Permian Insects.

Protohymen permianus Tillyard, Amer. Journ. Sci. (5) **11** (61): 58, 1926.

Fore wing: length, 10-13 mm.; width, 3 mm.; at the base the costa bends outward slightly, but there is no precostal area; R comes in contact with the costa before the divergence of Cu1 and Cu2, and at the middle of the pterostigma it diverges downward toward the apex; Cu2 strongly undulated. Cross-veins: one between R1 and R2+3; one between R2+3 and R4+5; two between R4+5 and MA; two or three between MA and MP; one between MP and Cu1; two or three between Cu1 and Cu2; two between Cu2 and 1A; one or two between 1A and the hind margin; the cross-veins between 1A and the hind margin are always attached to the distal half of the anal vein.

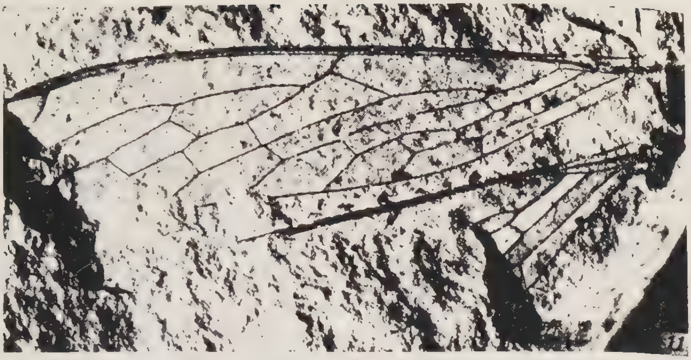
Hind wing: length, 9-11 mm.; width, 3.5 mm.; venation nearly identical with that of the fore wing; the length of the oblique vein between MP and Rs+MA is less than in the fore wing.

Holotype: No. 5001 (hind wing), Peabody Museum, Yale University; paratype: No. 5002 (fore wing), Peabody Museum; No. 1702, Tillyard collection.

In the Harvard collection there are ten specimens of this species, as follows: No. 3060ab, fore and hind wings complete, with fragments of head and thorax; No. 3061ab, fore and hind wings, folded together, but well preserved; No. 3062ab, hind wing, complete; No. 3063ab, fore wing, nearly complete; No. 3064ab, one pair of fore and hind wings (J. W. Wilson, collector); No. 3065ab, hind wing, complete except for the base; No. 3066ab, basal third of wing; No. 3067, middle third of wing; No. 3068ab, distal third of wing; No. 3070ab, basal two-thirds of wing. All specimens collected by F. M. Carpenter, unless otherwise indicated. In the Sellards collection there are two specimens: No. 1068, distal two-thirds of fore wing; No. 1558, distal third of wing.

The holotype specimen of this species is well preserved, but the base of the wing is missing. Since none of the other Yale specimens have this part preserved, Tillyard's figure is incomplete at the base. The wing is longer and more nearly petiolate than he supposed. The subcosta is

Psyche, 1930. PLATE 17.



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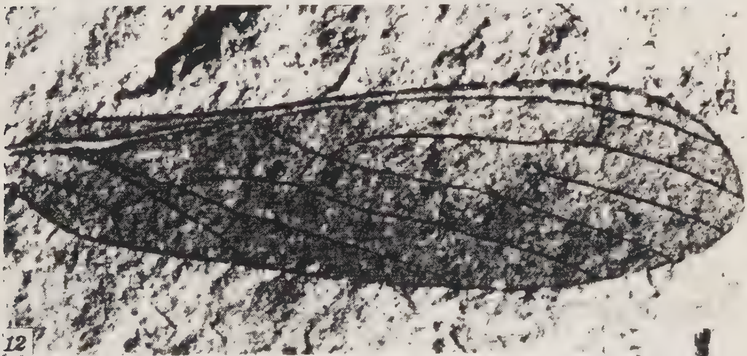

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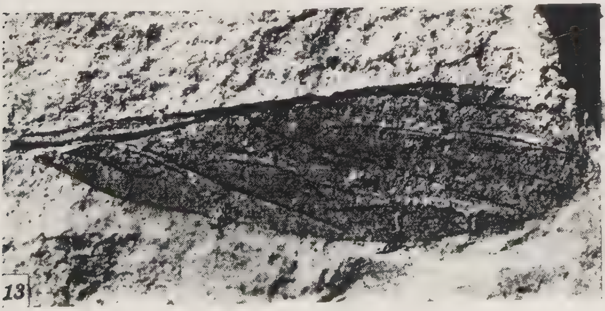

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14

Carpenter—Permian Insects.

not well preserved in the Yale material, but in several of the new fossils it is very clear; it does not extend to the pterostigma as thought by Tillyard. The pterostigma is also differently formed than shown in his figure; the photograph accompanying his paper (plate 4, fig. 1) demonstrates clearly the true nature of this structure. The costa and R1 widen slightly in the region of the pterostigma, so that there is no space formed between these veins until R1 diverges towards the apex. R1 appears to fork here, but in reality, as I shall show later, the upper "branch" which connects R1 to the margin is a modified cross-vein. There is considerable variation in the distribution of the cross-veins, and sometimes a cross-vein may be absent altogether or an extra one added. The holotype specimen has two cross-veins between 1A and the hind margin, but all the other specimens I have seen possess only one here. The short vein, resembling a cross-vein, between the base of Cu1 and R+M is apparently the basal part of MP.

Protohymen elongatus n. sp.

Fig. 2

Fore wing: length, 20 mm.; width, 3.5 mm.; extremely slender and pointed; R1 separating from the costa at the beginning of the pterostigma, so that there is a distinct space between these veins in the region of the pterostigma (text fig. 1); Cu1 diverges upward after its separation from Cu2, and touches R+M; Cu2 only very slightly undulated; cross-veins distributed essentially as in *permianus*, but the one between 1A and the hind margin is attached to the middle part of the anal vein.

Holotype: No. 3069ab, Museum of Comparative Zoology; F. M. Carpenter, collector.

This species is based on a well-preserved and nearly complete fore wing. The only part missing includes the area between the terminations of MP and R1, along the posterior border. *Elongatus* can readily be distinguished from the previous species by its more slender habitus and the corresponding tenuity of the veins.

Permohymen Tillyard

Permohymen Tillyard, Amer. Journ. Sci. (5) 8 (115), 1924.

Fore wing: very broad; R1 remaining in contact with costal vein only a little beyond the origin of Rs; pterostigmal space wider than in Protohymen, narrowly triangular; R1 without a definite cross-vein between it and the costal margin in the region of the pterostigma; Cu1 remains parallel to R+M and in contact with it for some distance after its origin; 9-10 cross-veins; cross-vein between 1A and the hind margin is attached close to the base of the wing.

Hind wing: much broader than the fore wing, especially at the base; venation similar.

Genotype: *Permohymen schucherti* Tillyard.

Permohymen schucherti Tillyard

Permohymen schucherti Tillyard, Amer. Journ. Sci. (5) 8 (44): 116, 1924.

Permohymen schucherti Tillyard, Amer. Journ. Sci. (5) 11 (61): 61, 1926.

Fore wing: length, 13 mm.; width, 3.5 mm.; costal margin bends outward at base; R1 comes in contact with costa just before termination of Sc; Cu2 straight; cross-veins: one between R1 and R2+3; one between R2+3 and R4+5; one between R4+5 and MA; two between MA and MP; one between MP and Cu1; two between Cu1 and Cu2; one between Cu2 and 1A; one between 1A and margin of wing.

Hind wing: length, 12 mm.; width, 4 mm.; pterostigma a little broader apically than in fore wing; venation similar.

Holotype: No. 5003, Peabody Museum; counterpart, No. 1704b, Tillyard collection.

In the Harvard collection there are four specimens of this species, as follows: No. 3071, fore wing complete; No.

3072a, apical half of wing (fore?); No. 3073, hind wing, complete and splendidly preserved; 3074ab, base of hind wing. In the Sellards collection I find one specimen, No. 308 (reverse, No. 309), fore wing, complete except for apex.

The holotype specimen consists of a very nearly complete fore wing and hind wing, with parts of the corresponding pairs. The bases of the fore wings are obscured by an abrupt bend in the surface of the rock, and the bases of the hind wings are missing entirely. Tillyard was therefore not able to obtain a clear vision of the venation at the base of the wings, and his figure of this part is incorrect. Cu1 is undoubtedly united with Cu2 at the base of the wing, but it runs along in contact with R+M for quite a distance before diverging backwards; this is essentially the same structure as in Protohymen, only in that genus Cu1 diverges from R+M much nearer to the base of the wing. The subcosta cannot, of course, be seen in the holotype, but it is clearly preserved in several of the Harvard specimens. It is a strongly developed vein, extending only a short distance beyond the posterior divergence of Cu1. The apex of the fore wing is not pointed as figured by Tillyard. The apex of the left wing, on which Tillyard apparently based his figure, is distorted by an irregularity in the surface of the rock. The true shape of the wing is clearly shown in the right wing of the holotype, as can be seen in the photograph accompanying Tillyard's paper (plate 4, fig. 2).

FAMILY DOTERIDAE

Fore wing: anterior margin slightly concave, the maximum curvature near the base of the wing; costal margin serrated; costal space broad basally, present along the entire anterior margin of the wing; Sc short, not extending as far distad as the origin of Rs; R remote from the costal margin at the base, approaching nearer to it at the middle of the wing; R1 starts to diverge from the costa near the middle of the wing; pterostigma weakly developed, slenderly oval; frequently the pterostigma is bordered distally by a well-developed cross-vein between R1 and the anterior

margin; stem of Cu curved posteriorly at the base; Cu1 and Cu2 diverging close to the base; 7-8 cross-veins.

The fore and hind wings have not been distinguished.

Doter Sellards

Doter Sellards, Amer. Journ. Sci. (4) 23: 355, 1907.

Doter Handlirsch, Denkschr. Akad. Wiss. Wien. Math. Naturw. (96) 82: 22, 1919.

Asthenohymen Tillyard, Amer. Journ. Sci. (5) 8 (44): 117, 1924.

Asthenohymen Tillyard, Amer. Journ. Sci. (5) 11 (61): 63, 1926.

Head small, oval; eyes small, oval, placed close together; antennæ long and slender with about 35 segments, the two basal ones several times as long as broad, the others about twice as long as broad; thorax broad; prothorax long, narrow, mesothorax short, metathorax about twice as long as the mesothorax; legs short and stout; femur and tibia nearly equal in length; 3 tarsal joints, the last bearing a pair of small claws; the last tarsal segment of front legs only a little longer than the others, the last tarsal joint of the middle legs about twice as long as the others; hind legs and basal segments of abdomen unknown; terminal four abdominal segments about twice as broad as long; last segment rounded posteriorly, bearing two very long, slender cerci, consisting of at least 52 segments (probably more), each segment with a pair of divergent hairs.

Wings moderately slender, nearly subpetiolate, apex well rounded; Rs divides into R2+3 and R3+4 about half way between its origin and termination; R2+3 terminates at the very apex; cross-veins constant in number, but variable in position.

Genotype: *Doter minor* Sellards.

Tillyard placed seven species of the Kansan Protohymenoptera in the genus Asthenohymen. Apparently the members of this genus rested with their wings back over the

abdomen, as thought by Tillyard, for all the specimens with the four wings preserved are in that position. This condition, of course, obscures or confuses the venation to such an extent that we cannot distinguish satisfactorily the fore and hind wings. Two specimens in the Yale collection are preserved in the position of rest, but both of these lack the bases of the wings. When we consider the species of Doter, therefore, we must bear in mind that we may be describing the fore and hind wings as separate species, although from the condition in the Protohymenidæ we should not expect much difference in the venation.

From a study of the forty-three specimens of Doter in the Harvard collection and the eleven Yale types, I am convinced that several of the species described by Tillyard are not valid. The data on which I base this conclusion follow:

(1) *Dunbari.* The true shape of the wing of the holotype is not shown in Tillyard's figure. The basal part of the holotype wing was hidden when he studied it by a small piece of the limestone matrix. When I removed this chip of rock, the whole wing was exposed, revealing an outline much like that in Tillyard's figure of *affinis*. The subcosta is quite clear in the type and is represented in Tillyard's figure, although it is not labeled. The costal space is broader basally than shown in the figure. There is a distinct cross-vein between R1 and R2+3 (R and M, Tillyard), although the supposed absence of this cross-vein was given by Tillyard as a key character.

(2) *Affinis.* The base of the wing of the holotype is not very well preserved, but nevertheless it shows a broad costal space. I am not sure whether the basal cross-vein between Cu1 and Cu2 is present or not; at any rate, the wing is so faintly preserved here that its possible absence in the fossil might easily be due to lack of preservation.

(3) *Gracilis.* The holotype wing is not so slender as shown in the figure; the costal space is broadened basally even more than represented. The pterostigmal area is distinctly darkened, even more than it is in the type of *stigmatazans.* A careful examination of the holotype under

good illumination shows that there is unquestionably a cross-vein between Cu2 and 1A basally, and another one between 1A and Cu2. The supposed absence of these cross-veins was used by Tillyard as key characters. 1A does not join Cu at the base of the wing, but curves downward and away from the stem.

(4) *Stigmatazans.* The type specimen has a broad costal area at the base, and is shaped like the preceding fossils. The pointed appearance of the apex, as shown in Tillyard's figure, was due to the fact that the anterior margin was covered by a piece of limestone when he studied it. By removing this fragment, I found that the apex was more rounded. The pterostigma, which is slightly darkened, is not so noticeable as that in *gracilis.* There is no cross-vein visible at the base between Cu1 and Cu2, but this absence is due in all probability to the poor preservation at that part of the wing; the cross-vein at the distal ends of these veins is exceedingly faint.

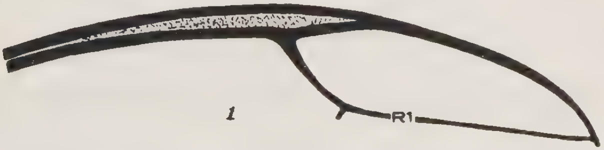
(5) *Kansasensis.* This wing is not so narrow as shown in Tillyard's figure (see my photograph of the type, fig. 12); when I first examined the fossil, the anterior margin was partly covered by a piece of the matrix, but this was removed and the costal area was found to be as broad as in the other fossils. The removal of this chip also exposed the subcosta, which is partly shown in Tillyard's figure, although it seems to have been confused by him with the base of the radius. The type specimen is splendidly preserved and is one of the best representatives of Doter which I have seen.

(6) *Stenobasis.* The apical portion of the holotype wing was not missing, as stated by Tillyard, but only covered by the limestone. When this matrix was removed and the whole wing exposed, I found that the shape was identical with that of *affinis;* the costal area is broadened basally. The pterostigmal area, not seen by Tillyard, is fully as dark as that in *stigmatazans.* Even under the best illumination and highest power of binocular magnification I could not discern 1A in the type, or the two cross-veins shown by Tillyard between 1A and Cu2. The base

of the wing is distorted by an irregularity in the surface of the rock.

(7) *Pusillus.* The costal space is broadened basally, not straight, as shown in the figure of the type; otherwise the shape of the wing is correctly represented. The pterostigma region is slightly darkened. The piece of limestone covering part of the posterior margin was removed, exposing the termination of Cu1; this vein is unbranched, not forked as supposed by Tillyard. There is a faint trace of a cross-vein between Cu1 and Cu2 at the base, but none is apparent distally.

From these observations on the type specimens and a comparison with the Harvard fossils, I believe it is clear that most of the characteristics which Tillyard used to distinguish the species do not hold. Furthermore, I am certain that none of the type specimens have the very base of the wing preserved. Most of the Harvard fossils also seem to have the base of the wing broken away at a point near the maximum width of the costal space; but several of the specimens show a more basal part, where the costal space narrows again, and the posterior margin bends inward considerably, the wing becoming subpetiolate. This I believe to represent the true shape of the wing in the



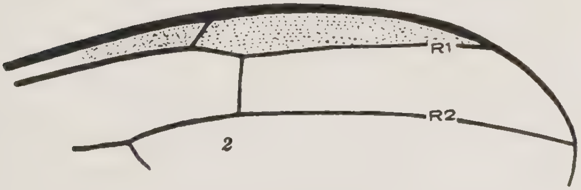


Fig. 1. Pterostigma of *Protohymen elongatus* n. sp.

Fig. 2. Pterostigma of *Doter minor* Sell., with cross-vein; specimen No. 3101, Mus. Comp. Zool.

genus *Doter* (see fig. 13). In classifying the wings of these insects, therefore, I consider *dunbari, gracilis kansasensis* and *stenobasis,* to be one species, which must be called *minor* Sellards by priority. *Affinis* and *stigmatazans* seem to comprise another species, chiefly distinguished from *minor* by the remoteness of 1A and Cu2; but these wings may be only the hind pair of the foregoing. By page precedence the name of the species must become *affinis. Pusillus* is removed all the other wings by its greater width.

Doter minor Sellards

Plate 2; text fig. 2; fig. 12, 13, 14

Doter minor Sellards, Amer. Journ. Sci., (4) **23**: 355, 1907.

Doter minor Handlirsch, Denkschr. Akad. Wiss. Math. Naturw. (96) 82: 22, 1919.

Asthenohymen dunbari Tillyard, Amer. Journ. Sci. (5) 8 (44): 117, 1924.

Asthenohymen gracilis Tillyard, Amer. Journ. Sci. (5) **11** (62): 66, 1926.

Asthenohymen kansasensis Tillyard, ibid, p. 67.

Asthenohymen stenobasis Tillyard, ibid, p. 68.

Length of body, excluding cerci, 4 mm.; length of antennæ, 3.5 mm.; length of cerci, 10 mm. Wing: length, 7-8 mm.; width, 2-3 mm.; slender, subpetiolate, broadest beyond the middle; costal space narrow at base, widest opposite the point of divergence of Cu1 and Cu2; R+M straight at base, diverging upwards rather abruptly; Cu1 and Cu2 usually close together at base, diverging distally; 1A fused with Cu at very base; pterostigma always present, but frequently only weakly preserved; cross-veins: one between R1 and R2+3; one between R3+4 and MA; two between MA and MP; two between MP and Cu; two

between Cu1 and Cu2; one between Cu2 and 1A; frequently a cross-vein is present in the pterostigmal region; posterior margin indented at the base.

Type: No. 62 Sellards collection, showing the thorax, abdomen, cerci, and folded wings.

In the Harvard collection there are twenty-five specimens of this species, aside from fragments; these are Nos. 3075-3094, and 3111-3115. The more important of these are as follows: No. 3078ab, complete wing; No. 3082ab, complete to very base; No. 3085ab, complete and finely preserved, the subcosta being very clear; No. 3086ab, complete, also with a distinct subcosta; No. 3111ab, nearly complete wings, with thorax and cerci; 3112ab, base of wing, head, thorax, and fine antennae; No. 3113ab, a whole specimen, thorax well preserved; No. 3114ab, most of wing and cerci; No. 3115ab, parts of wings, head, thorax, abdomen, legs, antennæ and cerci, all finely preserved. Tillyard has figured (1926a, p. 61) the "remains of head, thorax and legs" as preserved in specimen No. 5043ab of the Yale collection, showing three ocelli and one mandible. I have examined this specimen under various types of illumination and from all angles, but have been unable to make out any of the details which Tillyard has figured.

Doter affinis Tillyard

Asthenohymen affinis Tillyard, Amer. Journ. Sci. (5), **11** (61): 65, fig. 2.

Asthenohymen stigmatazans Tillyard, ibid, p. 66, fig. 4.

Length of wing, 7.5 mm.; width, 2.3 mm. Venation similar to that of *D. minor*, but 1A is remote from Cu2 and not connected with it by a cross-vein; wing broader at the base than *minor;* pterostigma weakly formed.

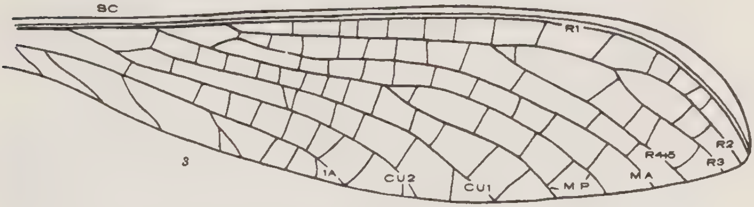
Holotype: No. 5050a Peabody Museum; counterpart in Tillyard collection. In the Harvard collection there is a complete wing of this species, No. 3095ab (F. M. Carpenter, collector). This species may represent the hind wing of *minor*.

Doter pusillus Tillyard

Asthenohymen pusillus Tillyard, Amer. Journ. Sci., (5) 11 (61): 68, fig. 7.

Length of wing, 5-7 mm.; width, 2-3 mm. Wing broad, especially at the base, but the costal space is not quite so broad as in *minor;* pterostigma is rather well developed; 1A is short and remote from Cu2, but is connected with it by a cross-vein.

Holotype: No. 5051, Peabody Museum. In the Harvard collection there are two fine specimens of this species: one of these (No. 3097ab) is about the size of the type, 5 mm. long; the other is 7 mm. long, but otherwise identical. As I have stated above, Tillyard erroneously thought that this species was characterized by a forked Cu1. Both the Harvard fossils show two cross-veins between Cu1 and Cu2, although only one was apparent in the faintly preserved holotype.



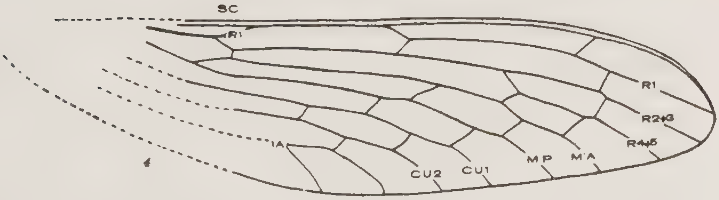


FIG. 3. Fore wing of *Aspidohymen triangularis* Brogn., from the Carboniferous of France (after Brongniart).

FIG. 4. Wing (hind?) of *Aspidohymen extensus* Mart., from Russian Permian (after Martynov).

THE VENATION OF THE PROTOHYMENOPTERA

Having considered the new fossils and the additional information which they give us on the wing structure of the Protohymenoptera, we are in a position to investigate the venation and to attempt to homologize the veins with those in other insects. Lameere, Martynov, and Tillyard have shown in recent years that the main longitudinal veins in an insect's wing are either convex or concave, and that the convexity or concavity is always constant for that vein. Thus, the subcosta, when viewed from the upper surface of the wing, is always concave ($^-$), R1 always convex ($^+$), Rs concave, etc.[2] In the more primitive insects, or at least in those with a fairly complete venational system, the convexities and concavities are strongly developed. Consequently, a well preserved fossil wing of such a type has the relief of the veins also preserved, and this is a great aid in identifying the veins and homologizing them with those in the wings of recent insects. Of course in the case of fossils, the *obverse* half presents the impression of the ventral surface of the wing, so that when we look at this half, we see the veins in the same relief as if we were viewing the original wing from the dorsal surface; that is, Sc is concave, R1 convex, etc. Conversely, the *reverse* half of the fossil is formed by the impression of the upper surface of the wing, so that we see the veins in the same relief as if we were looking at the wing itself from below; that is, Sc is concave, R1 convex, etc. Now the "key" to the identity of the two halves of a fossil wing is the subcosta; for it is the first vein in the wing below the anterior margin and it is present in nearly all insects. The subcosta is therefore easily recognized by virtue of its position, and when we find it concave in one-half of the fossil, we know we are dealing with the obverse piece, with the convexities and concavities of the veins just as on the dorsal surface of the wing itself. When we find the subcosta convex, we know we have the reverse half, with the relief of the veins in the negative position.

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[2] Of course when we state that a vein is convex or concave, we imply that we are observing the veins from the upper side of the wing.

When I commenced my study of the Protohymenoptera in the Harvard collection, I was astonished to find that in the *obverse* halves of the fossils (with Sc concave) the convexities and concavities of the other veins were directly opposite those which Tillyard described as characteristic of the Protohymenoptera; all the veins which he had indicated as convex ($^{+}$) were concave ($^{-}$) in my specimens, and *vice versa.* The explanation of this became clear, however, when I examined the Yale types which Tillyard had studied. In Protohymen and Permohymen the subcosta is crowded between R+M on one side and the costa on the other; only at the very base of the wing (see fig. 1) is it free and independent of these other veins, and here only can it be seen distinctly. In all the Yale specimens, as I have previously mentioned, the bases of the wings are either obliterated or very poorly preserved; consequently Tillyard was unable to see the subcosta where it was best developed. In the Doteridæ (Asthenohymenidæ) the subcosta is free from R and the costa, but it is quite short. Tillyard seems to have had some difficulty in identifying the subcosta in the Yale specimens of Doter, and concluded that it was "obsolescent." He says, "A peculiarity about this genus is the difficulty of determining the exact limits of the obsolescent Sc, the main vein R, and the delicate traces of the basal portions of M and Cu running beneath. This seems to be due to the fact that both costa and R are somewhat widened and flattened veins, while Sc and the basal part of M and Cu are very slender and faint. . . . It is possible that both Sc and Rs are really fused with R right to its apex. . . ." Here again I believe that Tillyard's difficulty was largely due to the fact that the bases of the wings of the Yale specimens of Doter were not well preserved, if preserved at all; this I have already mentioned in connection with the shape of the wings. The holotype *kansanensis* is the one exception to this, but when Tillyard examined this specimen, the base of the anterior margin was partly covered by a piece of limestone, as shown in his figure. When I studied the type, I removed this chip of rock with a needle, exposing the subcosta for nearly its full length. With the assistance of the photographer of the Peabody Museum I obtained a fine photograph

of this specimen, and it is reproduced here to show how well the subcosta really is developed in Doter (fig. 12). Only one-half of this specimen is now at the Peabody Museum, the other being in Dr. Tillyard's collection; the Yale half has the subcosta strongly concave, and is therefore the obverse. Now, when I compared this half with the obverses in the Harvard collection, I found that the convexities and concavities of all the veins agreed exactly. This means that Tillyard, who was not able to locate the subcosta in his specmens, and who consequently lacked the key to the identification of the two halves of the fossils, *confused the obverses with the reverses, so that all the veins which he thought were convex were really concave,* and *vice versa.* Consequently the veins of the Protohymenoptera cannot be interpreted as Tillyard supposed, for his R1 is really a concave vein, his Rs convex, etc. Martynov also made the same mistake in his interpretation of the veins in the Russian Protohymenoptera, *Aspidohymen extensus.* Unfortunately, the whole anterior border of the specimen was obliterated and did not show the subcosta. Apparently Martynov assumed that Tillyard's idea of the convexities and concavities was correct and based his own interpretation of the veins in Aspidohymen on the reverse.

We have now to identify the veins in the protohymenopterous wings according to our corrected understanding of the convexities and concavities of the veins. But the interpretation of the veins in this group is by no means an easy task; even a casual examination shows that several of the veins which existed in the primitive insect wing have been lost. The venation of the Protohymenoptera has been reduced so far that I do not believe we can homologize the veins with those in other insects until we have learned something of the ancestral condition of the venation and determined which veins have disappeared.

Martynov has already concluded from the nature of the wing membrane and the position of the wings at rest that the Protohymenoptera were close relatives of the Megasecoptera. Fortunately many details of the body structure of the Commentry Megasecoptera have been made known to us through the researches of Brongniart

branches, R2, R3 and R4^{+}5. The next vein is the media, which is fused with R basally according to Brongniart's figure; it diverges posteriorly a short distance before the origin of Rs, and then divides into its two main branches, MA ($^{+}$) and MP ($^{-}$). Shortly after its origin MA bends upwards towards Rs and is connected with it here by a short, stout cross-vein. MA is unbranched, but MP is forked near the middle of the wing. Cu separates from R close to the base of the wing and promptly divides into Cu1 and Cu2. In some of the Megasecoptera, as Mischoptera (plate 30, fig. 6), the anterior media (MA) not only bends towards Rs, but *actually fuses with it* for a short distance; and Cu1 diverges towards MP at its base. Now in Aspidohymen, the Russian Protohymenopteron (text fig. 4), Rs originates as in the Megasecoptera; R2^{+}3 and R4^{+}5 separate off as in Aspidothorax, but the former is unbranched. Hence, the structure of the radial sector in Aspidohymen is readily derived from that of the Megasecoptera by the elimination of the fork in R2^{+}3.

When we pass to the more highly developed wing of Protohymen, we find that MA has fused with Rs at its base, just as in some of the Megasecoptera. The free basal piece of MA, between its origin and junction with Rs, is very long and decidedly convex, not flat like a true cross-vein, as it was interpreted by Tillyard and Martynov.

Now if we examine the posterior media in the Protohymenoptera we at once note that it is not forked as in the Megasecoptera; the posterior branch of MP is the other vein which has been lost in the Protohymenoptera. In certain of the Megasecoptera, as I have already mentioned, the basal part of Cu1 curves upwards towards M, just as MP approaches Rs. Unfortunately, this part of the wing of Aspidohymen is missing, but in *Protohymen permianus* there is a short vein, resembling a cross-vein, between the base of Cu1 and R (see fig. 11). In *Protohymen elongatus*, Permohymen, and Doter, Cu1 bends upward and actually fuses with R at this point. Now in order to obtain this condition present in Protohymen from that of the Megasecoptera, we have only to suppose that Cu1 coalesced with MP at the base just as MA fused with R. According to this interpretation the "cross-vein" between

Cu1 and R at the base is really the free, short piece of the stem of M. This tendency for MA to coalesce with the radial sector, and MP to coalesce with Cu1 is found in nearly every order of insects where there is a marked reduction in the venation. Whether my conception of the changes in the structure of the media is correct or not, the fact remains that the convex vein just below Rs in the Protohymenoptera can only be MA, and the concave vein before Cu1 must be MP. The nature of the modifications which resulted in the elimination of the two veins is perhaps not so obvious; but by merely carryng out the coalescence already suggested or begun in the Megasecoptera, we obtain conditions so strikingly similar to what we actually find in the Protohymenoptera that I believe the process outlined above is the correct one.

So few are the specializations in the wings of the Protohymenoptera over those of the Megasecoptera that we have in this fact further proof of the very close affinity of these two orders. It is true that we postulated such a relationship at the beginning of our discussion of the wing venation in the Protohymenoptera; but the ease with which we can derive one type from the other is itself an indication of such an association. From all aspects, therefore—wing structure, body structure, and wing venation—the evidence points to the one conclusion. I am therefore led to agree with Handlirsch's original suggestion, that these insects are not only allied to the Megasecoptera, but are actually members of that order. They undoubtedly constitute a distinct suborder (Protohymenoptera), as specialized Permian representatives of the true Carboniferous Megasecoptera (suborder Eumegasecoptera).

There are two modifications in the wings of some of the Protohymenoptera which were not considered above, because they are obviously of no more than generic or specific importance. I refer to the broad wings of Permohymen, and the formation of a pterostigma in the Protohymenidæ. Some students of insect phylogeny may object to the idea of deriving insects with broad wings like those of Permohymen from insects with narrow or subpetiolate wings like those of the Carboniferous Megasecoptera; for petiolation is usually considered a modification of the normally

broad wings, exemplified in the Paleodictyoptera. But when the venation of the wing is not altered during the process of change in the shape of the wing, the broadening is of specific or even individual importance only. Many examples of this can be found in recent groups. In the Asilid genus Leptogaster the wings are frequently subpetiolate, while in Ospriocerus and Pogonosoma they are remarkably broad. In the Empidæ the wings are often subpetiolate, but in some species, as Rhamphomyia, they are enormously broadened, and almost oval. In this latter family also the broadening of the wings is frequently a secondary sexual characteristic of the male. But in none of these insects is the venation changed as the wings widen, aside from shift in the direction of the veins in the anal region. On the other hand, when the process of change in shape is accompanied by numerous modifications of the venation, then the breadth is of great phylogenetic value. I have already shown the impossibility of deriving the anisopterous dragon-flies from the petiolate Zygoptera, for here numerous changes in the venation would be necessary. In the genus Permohymen, however, we are dealing with the former type of modification in the shape of the wing, where there is no alteration of the veins. Aside from slight difference in the direction of the anal veins, the venation is exactly like that of Protohymen, which is as petiolate as the Carboniferous Megasecoptera. The assignment of such a broad-winged insect as Permohymen to the Megasecoptera is therefore not at all objectionable.

The pterostigma in the Protohymenidæ is a simple structure, much less of a specialization than Tillyard had supposed. In Aspidohymen there is no pterostigma, R1 being remote from the costal margin at this point; but there is a strong, oblique cross-vein connecting R1 with the costa in the pterostigma region. In *Protohymen permianus* R1 fuses with the costa up to the pterostigmal area, where it diverges downward to the apex of the wing; the pterostigmal cross-vein is present, and even more strongly developed (R1 of Tillyard). In *Protohymen elongate* R1 is slightly removed from the costa in the pterostigmal region,

and the wing membrane between the veins is thickened and darkened. In Permohymen R1 is even more removed from the costa; the pterostigmal cross-vein is only weakly formed, as a slight thickening of the apical edge of the pterostigma itself. The Doteridæ have only a very feeble pterostigma; R1 is remote from the margin, and the area between is slightly darkened. In most specimens there is no pterostigmal cross-vein, but in other specimens of the same species there is a definite cross-vein here. The pterostigma in the Protohymenoptera is very primitive in structure and does not, therefore, eliminate them from the Megasecoptera; it is merely another slight specialization developed in connection with the reduction of the venation.

RELATIONSHIP WITH THE HYMENOPTERA

Now in demonstrating that the Protohymenoptera are megasecopterous we do not *necessarily* prove that they have no connection with the Hymenoptera. Only the wording of the question becomes slightly changed: were the Hymenoptera evolved from the Megasecoptera? If we attempt to derive the Hymenoptera in this way, we at once remove the order from all the other holometabolous insects, unless we postulate that they also originated from the Megasecoptera. The latter assumption hardly deserves consideration, for the Megasecoptera were far more specialized than the lower members of the panorpoid orders. The former proposition—that the Hymenoptera were evolved separately from the other holometabolous insects and developed complete metamorphosis independently—has already been offered by Tillyard (1926b). He says, "The fossil evidence is now fairly strong that there were three distinct groups of holometabolous insects which evolved a pupal stage independently of one another in the Permian period. These are (a) the Mecopteroid orders, namely, Mecoptera, Neuroptera, Paramecoptera, Paratrichoptera, Diptera, Trichoptera, Lepidoptera, and Siphanaptera; (b) the Hymenopteroid orders, Protohymenoptera and Hymenoptera; and (c) the Coleopteroid orders, Protocoleoptera, Coleoptera, and their parasitic offshoot, Strep-

siptera."[4] Although I cannot agree with Tillyard's statement that the fossil evidence indicates this polyphyletic origin of holometabolism, it is clear that the question of the relationship between the Protohymenoptera and Hymenoptera is a complicated one and not easily answered.

So far as the body structure of the Protohymenoptera is concerned, there is really nothing definite either way. Of course we should hardly have expected to find such well developed cerci in the direct ancestors of the Hymenoptera, but that is only an indication that the body structure of the Protohymenoptera was much more primitive than the wing venation. The three-segmented tarsi of Doter are more specialized than the five-segmented ones in the primitive Hymenoptera; but some of the more primitive, unknown Protohymenoptera may have had five-segmented tarsi also. I believe, however, that Martynov's arguments, based on the nature of the wing membrane and the position of the wings at rest, are definite proof that the Protohymenoptera had no connection with the Hymenoptera; at least his arguments are sufficient to make Tillyard's conclusions seem doubtful.

But even if it is true that the Hymenoptera are derivatives of the Protohymenoptera, and that the venation of the former has evolved from that of the latter, the venational system which Tillyard proposed for the Hymenoptera must be changed, for I have shown above that Tillyard had erroneously interpreted the veins in the Protohymenoptera by confusing the obverses with the reverses. The veins which he designated as M1 and M2 in the Hymenoptera (1924, p. 119, fig. 4) would be branches of Rs; his M3+4 would be MA; his Cu1 would be MP; and so forth with the rest of the veins. In other words, if we

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[4] A few remarks may be necessary on the Carboniferous *Sycopteron symmetricum* Bolton (Commentry). The specimen on which this species was based is poorly preserved, and lacks the base and apex of the wing. Bolton considered the fossil to be a possible relative of the psocids, but Tillyard (1927) regarded it as a Carboniferous representative of the Protohymenoptera. Martynov thinks that Bolton's opinion is "not improbable." For my own part, I fail to find anything in the fossil which is at all reminiscent of the Protohymenoptera; the few features of the wing that are preserved seem to be more orthopteroid than anything else.

accept Tillyard's theory that the Protohymenoptera were the ancestors of the Hymenoptera, we must reject his interpretation of the hymenopterous venation based upon that association and substitute another one founded upon the corrected interpretation of the protohymenopterous wings advanced in this paper. Conversely, if his system of hymenopterous venation is the correct one, we must reject his doctrine of the origin of the Hymenoptera.

As I have mentioned above there are a few structures in the Hymenoptera (such as the polynephric Malphigian system) which isolate the group slightly from the other holometabolous insects; but so many other features are identical in the Hymenoptera and panorpoid orders that we can safely say that the comparative morphology of all these insects, especially in the developmental stages, demonstrates satisfactorily that the Hymenoptera arose in common with the other holometabolous forms (see Crampton, 1927, etc.). It is true that the venation of the Hymenoptera, as interpreted by Comstock, MacGillivary, and Tillyard, is not in complete agreement with that of the Mecoptera and allies; but Dr. Martynov, after an extensive study of the wings of the Hymenoptera, has concluded (1930) that the "venation in the Hymenoptera, though very specialized, shows many features of similarity with that of the Megaloptera and Mecoptera, thus proving that the Hymenoptera evolved from ancestors somewhat intermediate between the Megaloptera, Raphidioptera, and Mecoptera. The resemblance of the wings of the Megasecoptera, or the Protohymenoptera to those of the Hymenoptera (and Mecoptera) is purely superficial.[5]" Although Martynov's paper is still in the process of publication, it seems already certain that the Protohymenoptera and the rest of the Megasecoptera have nothing in common with the Hymenoptera.

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[5] Martynov has suggested that since the name "Protohymenoptera" is not appropriate for these fossils, it should be changed; and he proposes "Synsecoptera." This procedure does not seem practicable to me, for we already have other "Proto" orders (as Protodonata) which are no longer regarded as ancestral to the recent order concerned. This policy also means that investigators with diverse views on the affinities of the fossil would refer to the order under different names.

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EXPLANATION OF PLATES

PLATE 15

Fig. 1. Wings of *Protohymen permianus* Till.
Fig. 2. Fore wing of *Protohymen elongatus*, n. sp.
Fig. 3. Wings of *Permohymen schucherti* Till.

PLATE 16

Fig. 4. Wing of *Doter minor* Sell.

Fig. 5. Front leg of *D. minor;* specimen No. 3115a, Mus. Comp. Zoölogy.

Fig. 6. Middle leg of *D. minor;* specimen No. 3115a.

Fig. 7. Antenna of *D. minor*; specimen No. 3115a, 3112a.

Fig. 8. Head, prothorax, and mesothorax of *D. minor* (lateral): No. 3115a.

Fig. 9. Thorax of *D. minor* (dorsal): No. 3113a.

Fig. 10. Last five abdominal segments and cerci of *D. minor;* No. 3115a.

PLATE 17

Fig. 11. Photograph of obverse of *Protohymen permianus* Till., specimen No. 3060a, Mus. Comp. Zoölogy.

Fig. 12. Photograph of holotype of *Asthenohymen kansasensis* Till.; No. 5044a, Peabody Museum.

Fig. 13. Photograph of wing of *D. minor*, specimen No. 3087a, Mus. Comp. Zoölogy.

Fig. 14. Photograph of part of cerci of *D. minor*, specimen No. 3115a, Mus. Comp. Zoölogy.

A REVISION OF THE AMERICAN SPECIES OF THE GENUS OZYPTILA

By Elizabeth B. Bryant

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The genus Ozyptila was made by Simon in 1864 for the single species *Thomisus claveatus* Walckenaer (Ins. Apt.; 1837, 1, p. 510, Aug., 1833, Pyrenees), and wrongly identified as *Thomisus hirtus* Savigny, 1837, from Egypt. *O. claveata* of Walckenaer has not been recognized and in 1875 (Arach. France, 2, p. 211), Simon renamed the species that has been called *claveata* by Blackwell and others *O. blackwalli*, and selected *Thomisus brevipedes* Hahn as type of the genus.

The genus has a wide distribution in Europe with many species. In America all the species were known first from females, wth the exception of *O. marshalli* Barrows. Recently in revising the material at the Museum of Comparative Zoölogy the males have been identified and two new species were found. The males are easily distinguished by the palpi and the females by the epigynes. The clavate bristles may have specific value, but they are easily broken and the scar is difficult to see, so that they are found to be unsatisfactory. The number and position of the spines on the anterior legs is apparently constant throughout the genus, with the possible exception of *O. nevadensis* Keyserling, which is known only from the description. This is supposed to have two lateral spines on the first metatarsi instead of one. The color markings are also disappointing.

The genus is not well represented in collections, as the spiders are small, of a dull brown color with indistinct marks and as they live on the ground they are easily overlooked. Nine species have been recognized, known by both sexes, with the exception of *O. neglecta* and *O. marshalli,* which are represented only by the males. *O. mar-*

shalli is the only species not in the Museum of Comparative Zoölogy collection, and that is known only by the type.

I am greatly indebted to Mr. Banks for his unfailing kindness and help, and to Mr. J. H. Emerton for the generous use of his collection. Dr. W. M. Barrows has very kindly allowed me to examine the type of *O. marshalli*, and has generously given to the Museum of Comparative Zoölogy *O. neglecta* collected by him at Hayden Falls, Columbus, Ohio.

Ozyptila

Cephalothorax slightly elevated. Anterior and posterior rows of eyes procurved, posterior row longer, laterals larger than medians and on separate tubercles, the anterior being the larger. Quadrangle higher than wide, usually with parallel sides, but occasionally wider in front. Abdomen depressed, broad at base and rounded behind. Legs short and stout, I and II longest, tibia with 2-2 spines, metatarsus, 2-2-2 spines beneath and one or more lateral. Cephalothorox and abdomen roughened, and with the legs usually covered with clavate bristles and spatulate hairs. Male palpus rather short, tibia but little longer than patella, with two or three apophyses. Palpal organ simple. But little difference in size and markings between the sexes.

Ozyptila

Males

1. Tibia of male palpus with two apophyses, one superior and one inferior 2
   Tibia of male palpus with three separate apophyses, one superior, one inferior and a small one intermediate 7
2. Superior apophysis forked, upper branch bent almost parallel to tibia .... *marshalli*
   Superior apophysis not forked 3
3. Superior apophysis slender and more than half the length of the tarsus; inferior apophysis thickened

bent downward, embolus long and tip bent at right angles .... *conspurcata*

Superior apophysis less than half the length of the tarsus 4

4. A crescent-shaped piece in lower part of palpus.... 5

No crescent-shaped piece in palpus 6

5. Superior apophysis of tibia, short and very heavy, crescent-shaped piece with serrate edge................ *modesta*

Superior apophysis slender, reaching almost to middle of tarsus .... *americana*

6. Inferior apophysis slender and straight, embolus following curve of palpal cavity .... *monroensis*

Inferior apophysis thin and folded, lower apophysis of palpus bifid .... *neglecta* sp. n.

7. Superior apophysis more than half the length of tarsus, slender, with a small tooth on upper margin near base; inferior apophysis more than half as long as superior .... *formosa* sp. n.

Superior apophysis less than half as long as tarsus 8

8. Superior apophysis slender and sinuous, inferior apophysis short, scarcely reaching the palpus, embolus short and ending in a curve.............................. *pacifica*

Superior apophysis stout and curved, inferior apophysis as long as superior and intermediate leaf-like and folded almost double .... *floridana*

Ozyptila americana Banks

Figs. 1, 15

Psyche, 1895, 7, p. 242; ♀ N. Y.; Ithaca
Oxyptila conspurcata Emerton.
Trans. Conn. acad.; 1894, 9, pl. 4, fig. 7c.

♂ 3 mm. long.

Cephalothorax brown with a broad, irregular dark stripe each side of the median light stripe; yellow between median eyes; irregular marginal dark stripe; abdomen brown with dark spots and blotches and irregular cream color spots at base; legs brown, femora blotched with darker brown, tibiæ, metatarsi and tarsi light; spines, one spine above on femora I, II and III; I tibia 2-2, metatarsus 2-2-2, 1 lateral, all paired spines longer than diameter of joint. No clavate bristles on edge of clypeus, a pair of small clavate bristles between median eyes. Quadrangle slightly wider in front than behind.

Palpus. Tibia no longer than patella. Superior apophysis of tibia, slender and reaching to the middle of the tarsus; inferior apophysis slender, curving and ending in an enlarged hook bent away from the palpus. Palpal organ rather simple, superior apophysis with widely separated tips and a rounded lobe between, opposite is a sharp black cusp; on the lower opposite side is a dark piece curved to the contour of the palpus. This corresponds to the crescent-shaped piece in *O. modesta.* The embolus ends in a flattened tip which rests on the superior apophysis.

♀ 4 mm. long.

Cephalothorax brown with dark stripe each side of median light stripe and an irregular dark margin, cream color between the eye rows; abdomen brown with dark spots and a few cream color stripes; sternum and coxæ light brown, venter mottled; legs, brown, I femur mottled; spines, one spine above on femora I, II and III; I tibia 2-2, metatarsus 2-2-2, 1 lateral; all paired spines longer than diameter of joint, clavate bristles on clypeus longer than distance between A. M. E., pair of clavate bristles between M. E. and a clavate bristle below P. L. E. Quadrangle of eyes a little wider in front than behind.

Epigynum. A broad U-shaped depression with two small dark dots behind and the usual median lobe at the anterior part, much smaller than in *O. conspurcata.*

Type. 1 ♀, 2 juv. ♀, N. Y.; Ithaca, N. Banks Coll.

1 ♀, Can.; Ottawa bog, 1883, J. H. Emerton Coll., fig. as *O. conspurcata,* Trans. Com. acad.; 1894, 9, pl. 4, f. 7c. 1 ♀, N. H.; Intervale, Aug., 1910, E. B. Bryant Coll.; 1 ♂, 1 ♀, North Woodstock, 4 June, 1908, J. H. Emerton coll., 1 ♀, Jackson, 20 Feb., 1906, J. H. Emerton coll.

Ozyptila conspurcata Thorell

Fig. 2, 16.

Bull. U. S. Geol. Surv.; 1877, 3, p. 496; ♀, Colo.; Manitou Spring, 13 July.

Oxyptila georgiana Keyserling, Spinnen Amer.; Laterigradæ, 1880, p. 52, pl. 1, f. 26. "Many ♀ Peoria, Georgia, Simon Coll."

Oxyptila conspurcata Emerton, Trans, Conn. acad.; 1894, 9, p. 417, pl. 4, fig. 7 (nec 7c).

♂ 3 mm. long.

Cephalothorax brown with distinct light median stripe, sides mottled, with dark spot each side of median stripe; abdomen yellow with scattered cream colored dots and streaks and two pairs of laterally elongated dark spots near the center; sternum and coxæ light, venter light, spotted with dark; legs, I and II darker than III and IV. I femur mottled, the other joints clear, bright brown; spines, one spine above on femora I, 11 and III; I tibia 2-2, metatarsus 2-2-2, as long or longer than diameter of joint, no lateral. No clavate bristles on clypeus. Quadrangle as wide behind as in front.

Palpus. Superior apophysis very long and slender, parallel to tarsus and more than half as long; inferior apophysis short and bent. Palpal organ simple, a small dark cusp near the center near the large dark body; embolus long, slender, curving and resting on this central piece.

♀ 4 mm.

Cephalothorax brown, markings not as distinct as in male, abdomen darker and marks less distinct; sternum and coxæ light; legs marked same as in male, but the paired spines longer. Clavate bristles on edge of clypeus not as long as distance between A. M. E. Quadrangle as wide behind as in front.

Epigynum. The median anterior lobe is large and has a clear center with a small central spot; beneath are dark converging edges.

1 ♀ Can.; Laggan, J. H. Emerton Coll.; 1 ♀ N. H.; Intervale, Aug., 1919, E. B. Bryant Coll.; 1 ♂, 1 ♀ Mass.; Holliston, 10 June, 1924, Emerton and Banks coll.; 3 ♀ N. Y.; Ithaca, N. Banks Coll.; 1 ♀ Cold Spring Harbor, 25 June, 1903; J. H. Emerton coll.; 1 ♂ Ill.; Riverside, 8 June, 1912, N. Banks Coll.; 1 ♀ Iowa; Ames, N. Banks Coll.

Ozyptila floridana Banks

Figs. 3, 4, 18.

Psyche, 1895, 7, p. 243. "1 ♀ Fla.; Punta Gorda."

♂ 2.5 mm. long.

Cephalothorax brown, mottled with darker brown to form four irregular stripes; abdomen brown with irregular dark marks in bands, cream color blotches on basal margin; legs, basal part of femora, metatarsi and tarsi light, patella and tibiæ shaded with dark. Spines, one spine above on femora, I, II and III. I tibia 2-2, metatarsus 2-2-2, 1 lateral, the paired spines on metatarsus longer than diameter of joint. No clavate bristles on edge of clypeus, but pair of short clavate bristles between median eyes, and a long clavate bristle over coxæ I. Quadrangle wider in front than behind.

Palpus. Superior apophysis short and bent at an angle, inferior apophysis slender and straight and about the length of the superior and extending a short distance on palpus; intermediate apophysis a thin plate folded almost double. Palpal organ very simple, without apophyses and embolus ending in a curve following contour of palpus.

♀ 4 mm. long.

Cephalothorax brown mottled with a darker brown, yellow between the eyes; abdomen dark with few irregular markings; legs, tarsi light, and all other joints mottled with dark brown; sternum, coxæ and venter mottled. Spines, one spine above on femora, I tibia 2-2, metatarsus 2-2-2, 1 lateral, all paired spines as long or longer than the diameter of the joint. Clavate bristles on edge of clypeus as long as distance between A. M. E., a pair of clavate bristles between median eyes, and one long clavate bristle on margin above coxæ I. Many small clavate bristles on cephalothorax and abdomen, spatulate hairs on legs arranged in rows. Quadrangle wider in front than behind.

Epigynum. A shallow depression divided by a septum, on each side large oblique opening. The usual anterior lobe is large and quite remote from the other parts.

1 ♀ Type. Fla.; Punta Gorda, Mrs. A. T. Slosson coll.; 1 ♀, 2 ♂, Dunedin, 1927, W. S. Blatchley coll.

Ozyptila formosa sp. n.

Figs. 5, 7, 17.

♂ 3 mm. long.

Cephalothorax dark brown, median light stripe very obscure at anterior portion; abdominal markings indistinct; legs, I femur, patella and tibia dark brown, slightly mottled with light brown; II, III, IV femora light yellow at base, patellæ and tibiæ dark brown; all tarsi and metatarsi light yellow; sternum, coxæ and venter light without markings. Spines; one spine on upper side of all femora; I tibia 2-2, metatarsus 2-2-2, no lateral; II tibia 2-2, metatarsus 2-2-2, 1 lateral; all paired spines longer than diameter of joint. Quadrangle of eyes slightly narrowed posteriorly. Clavate bristles small and only ordinary bristles on clypeus.

Palpus. Superior apophysis of tibia, with a slight tooth near base on the exterior side, prolonged into a sinuate spine more than half the length of the tarsus, and parallel with it. Inferior apophysis about half the length of the superior, slender and ending in slightly enlarged tip, which rests against a blackened lobe on the lower side of the palpus. The superior and inferior apophyses are separated by a white intermediate lobe. The palpal organ is very simple and has, like the typical Xysticus, a superior and inferior apophysis widely separated; between the two is a small black cusp. At the opposite side is a dark crescent-shaped piece. The embolus is short and rests against the superior apophysis. There is a slight tutaculum similar to Xysticus.

♀ 4 mm. long.

Cephalothorax dark brown with median light stripe extending to clypeus; sides mottled; abdomen brown with irregular markings in a light cream color and a darker brown; legs not as dark as in the male, the femora more spotted and the contrast not as great between the tarsi and tibiæ. Spines, the same as in the male, except I metatarsi has 1 lateral. Clavate bristles on clypeus as long as distance between A. M. E. Cephalothorax, abdomen and legs covered with white, spatulate hairs. Quadrangle of eyes a little wider in front than behind.

Epigynum. Two oval depressions separated by a septum. At the anterior end is the usual opening with a small hood-like projecton.

Type. 1 ♂, Fla.; Royal Palm Park, 24 March, 1925, W. S. Blatchley coll.

Co-types. 3 ♀♀ Fla.; Royal Palm Park, March and April, W. S. Blatchley coll.

This species is nearer *Ozyptila brevipes* Hahn, than any American species. It differs from the other American species in the greater length of the upper apophysis of the male tibia and the characteristic vulva.

Ozyptila marshalli Barrows

Figs. 8, 10.

Ohio journ. sci.; 1919, 19, p. 357, pl. 15, f. 2, "1 ♂ Ohio, Sugar Grove, 11 Sept., 1917."

♂ 3 mm. long.

Cephalothorax dark golden brown, with four darker stripes, lateral broader, the median with a darker line in the center which reaches the thoracic groove; abdomen light with dark marks arranged as parallel stripes on sides but obscure in the center; legs light golden brown, much lighter than the cephalothorax, with faint dark blotches on the first femur, patella and tibia; posterior legs much lighter and markings more obscure. Metatarsi and tarsi of all legs light yellow. Spines, one spine on upper side of all femora; I femur, 3 basal spines, tibia 2-2, metatarsus 2-2-2, 1 lateral. Clavate bristles on clypeus half as long as distance between A. M. E. A long, clavate bristle on margin of cephalothorax above palpus. Eyes; quadrangle wider in front than behind.

Palpus. Tibia no longer than patella; superior apophysis of the tibia bent and almost parallel to the upper edge of tibia; from the basal part a smaller spur bent downward. Inferior apophysis slender with an enlarged tip. Palpal organ simple, without apophyses; embolus ending with a bifid tip about the middle; under this are two slender, dark rods close to the largest part of the organ.

Known by the type only.

Type 1 ♂. Ohio; Sugar Grove, 11 Sept., 1917, W. M. Barrows coll. Ohio State Univ.

Ozyptila modesta Scheffer

Figs. 6, 20.

Xysticus modesta Scheffer, Ent. news, Phila.; 1904, 15, p. 257, pl. 17, f. 1. "Several females . . . Manhattan (Kans.), in June."

Ozyptila beaufortensis Strand, Arch. Naturges, Berlin, 1916, 81, A. 9, p. 124. "2 ♂ ♂ von Beaufort, N. California."

♂ 3.8 mm. long.

Cephalothorax brown, mottled behind the eyes, median light stripe as wide as P. L. E. to about half the width at posterior margin; sides mottled with darker brown and a distinct dark marginal stripe; a pair of light spots at posterior part; abdomen pale yellow with darker marks, muscle spots not conspicuous; sternum with dark marks above margin, coxæ light; legs, I femur light, more than half covered with dark brown marks; tibia, metatarsus and tarsus clear yellow; basal part of femora II, III and IV clear yellow with dark rings at apex of femora, middle and apex of tibiæ; tarsi and metatarsi light. Venter mottled. Spines, I femur 2 above, one spine above on femora II, III and IV. I tibia 2-2, about diameter of joint, metatarsus 2-2-2, longer than diameter of joint, no lateral.

A pair of small clavate bristles between median eyes, and no clavate bristles on margin of clypeus. Quadrangle of eyes as wide in front as behind.

Palpus. The superior apophysis of the tibia is short and stout; the inferior apophysis is short with an enlarged tip, and extends only a short distance on the palpal organ. The palpal organ is simple. The superior apophysis is distinctly lobed, with a small dark cusp between the two lobes. In the opposite side is a large crescent-shaped body with a distinct serrate edge. This corresponds to a smaller one found in *O. americana* and a much heavier piece in *O. formosa*. The embolus is short and curved, with a flattened tip which rests on the upper apophysis.

♀ 5 mm. long.

Cephalothorax brown, with two dark stripes each side of median light stripe; light band between eye rows; sternum, coxæ and venter light and mottled with darker brown; legs, I and II mottled and much darker than III and IV. Spines, one spine above on femora I, II and III; I tibia 2-2, not as long as diameter of joint, metatarsus 2-2-2, 1 lateral, paired spines longer than diameter of joint. Clavate bristles on edge of clypeus not as long as distance between A. M. E., a pair of clavate bristles between M. E. and a long clavate bristle on margin above coxæ I. Head rather broad. Quadrangle of eyes as wide behind as in front.

Epigynum. Wider than long; a central septum extends forward in a sharp point; behind are the two small dark spots, more widely separated than in *O. americana,* and in front the usual median lobe.

Co-type 1 ♀ Kans.; Manhattan, 10 June, Scheffer coll.; N. Banks coll.; 1 ♂ Va.; Falls Church, N. Banks coll.; 1 ♂, 1 ♀, Ind.; Pine, N. Banks coll.

The male described by Strand as *Ozyptila beaufortensis,* from Beaufort, N. California (sic) is undoubtedly this species.

Ozyptila monroensis Keyserling

Figs. 9, 19.

Verh. zool. bot. Ges. Wein; 1883, 33, p. 671, pl. 21, f. 19. "♀ Va.; Fortress Monroe, Marx Coll."

♂ 1.8 mm. long.

Cephalothorax dark brown, median stripe very faint, light mark at the end of the thoracic groove; abdomen with irregular dark markings; legs clear brown without markings. Spines; I femur, 1 spine on upper side, tibia 2-2, a little longer than diameter of joint, metatarsus 2-2-2, longer than diameter of joint, no lateral; no spines on anterior surface of femora II, III, IV. Quadrangle as wide in front as behind. Clavate bristles on clypeus short.

Palpus. Tibia very broad, especially above the middle, superior apophysis short slender spur, inferior apophysis short with a slightly enlarged tip. Palpal organ simple, with two slender apophyses about the middle and the embolus following the curve of the cavity.

♀ 3 mm. long.

Cephalothorax bright brown with median stripe a little lighter; light mark at end of thoracic groove; abdomen coffee color with paired dark blotches; venter brown with scattered light spots; legs clear brown, little lighter than the cephalothorax without markings, but distinct light rings at the ends of patellæ and tibiæ. Spines; I femur, 1 spine on upper surface, tibia 2-2, metatarsus 2-2-2, 1 lateral on basal third; paired spines at least twice the diameter of the joint; no spines on anterior surface of femora II, III and IV. Clavate bristles on clypeus longer than distance between A. M. E. Quadrangle as wide in front as behind.

Epigynum. The small paired openings more than twice their diameter apart. The median hood-shaped body or lobe, rather large and connected with the paired cavities below.

Found from Long Island, New York, south to Virginia, and west to Ohio and Illinois.

Ozyptila neglecta sp. n.

Figs. 11, 14.

♂ 2.8 mm. long.

Cephalothorax brown, median light stripe very faint, sides mottled, darker about margin; abdomen with irregular dark marks arranged about the five muscle spots; narrow cream color line around anterior margin; legs light brown without markings, femora darker than other joints. Sternum light with dark marks opposite coxæ; coxæ light, venter pale with transverse dark lines. Spines; I femur, 1 on upper side, tibia 2-2, metatarsus 2-2-2, no lateral; no spines on II, III and IV femora. Clavate bristles on clypeus shorter than space between A. M. E. Quadrangle of eyes as wide in front as behind.

Palpus. Tibia very broad, especially before the middle. Superior apophysis short and pointed; inferior apophysis thin and folded. Palpal organ simple, with a bifid apophysis half surrounding a dark circle about in the center. Embolus ending with a short curve near the top of the palpus.

Type. 1 ♂, Ohio; Columbus, Hayden Falls, 13 June, 1926, W. M. Barrows coll.

Ozyptila pacifica Banks

Figs. 12, 13, 21.

Psyche, 1895, 7, p. 243, "1 ♀, 1 ♂, Juv. Wash.; Olympia, T. Kincaid coll."

♂ 3 mm. long.

Cephalothorax brown, median stripe mottled behind eyes but not a clear yellow in posterior half; sides with two pairs of interrupted darker stripes; abdomen pale, with white, broken lines and dots at base, and a pair of widely separated dark spots about the middle; apex much darker than basal portion; sternum, coxæ and venter light; legs light brown, I and II femora mottled with a darker brown, other joints clear yellow; broken dark bands at tip of III and IV femura and base of tibiæ III and IV. Spines; one spine above on all femora, I tibia 2-2, metatarsus 2-2-2, no lateral; all spines longer than diameter of joint. Clavate bristles between median eyes and on edge of clypeus as long as distance between A. M. E. Quadrangle of eyes as wide in front as behind.

Palpus. Superior apophysis short and sinuous, inferior apophysis short and bent downward, between the two a rounded white lobe. Palpal organ with two apophyses bent downward on the outer side and a dark cusp on the opposite, lower side; embolus ending in a thickened tip near the upper part of the palpus.

♀ 4 mm. long.

Cephalothorax bright brown, median stripe mottled about eye region, but a clear yellow in posterior half; sides faintly mottled; abdomen pale with cream color lines and spots about basal portion and posteriorly two or three interrupted darker bands; sternum and coxæ pale; legs a little lighter than cephalothorax, I and II without marks, III and IV with broken dark bands at top of femora and patellæ and at base of tibia IV. Spines, one spine above on femora I, II and III; I tibia 2-2, as long as diameter of joint, metatarsus 2-2-2, 1 lateral; the paired spines longer than diameter of joint. Clavate bristles on edge of clypeus equal to distance between A. M. E. Quadrangle as wide in front as behind.

Epigynum. Median lobe close to dark bodies, under the skin and paired openings a diameter apart.

Type. 1 ♀, Wash.; Olympia, T. Kincaid coll.; N. Banks coll. 1 ♂, Col.; Florissant, N. Banks coll. 1 ♀ B. C.; Metlakatla, J. H. Keen coll., N. Banks coll. 1 ♂, 1 ♀, B. C.; Masset, J. H. Keen coll., N. Banks coll.

EXPLANATION OF PLATES

PLATE 18.

Fig. 1. *O. americana* Banks, ventral view of palpus.
Fig. 2. *O. conspurcata* Thorell, ventral view of palpus.
Fig. 4. *O. floridana* Banks, ventral view of palpus.
Fig. 4. *O. floridana* Banks, lateral view of palpus.
Fig. 5. *O. formosa* sp. n., lateral view of palpus.
Fig. 6. *O. modesta* Keys., ventral view of palpus.
Fig. 7. *O. formosa* sp. n., ventral view of palpus.

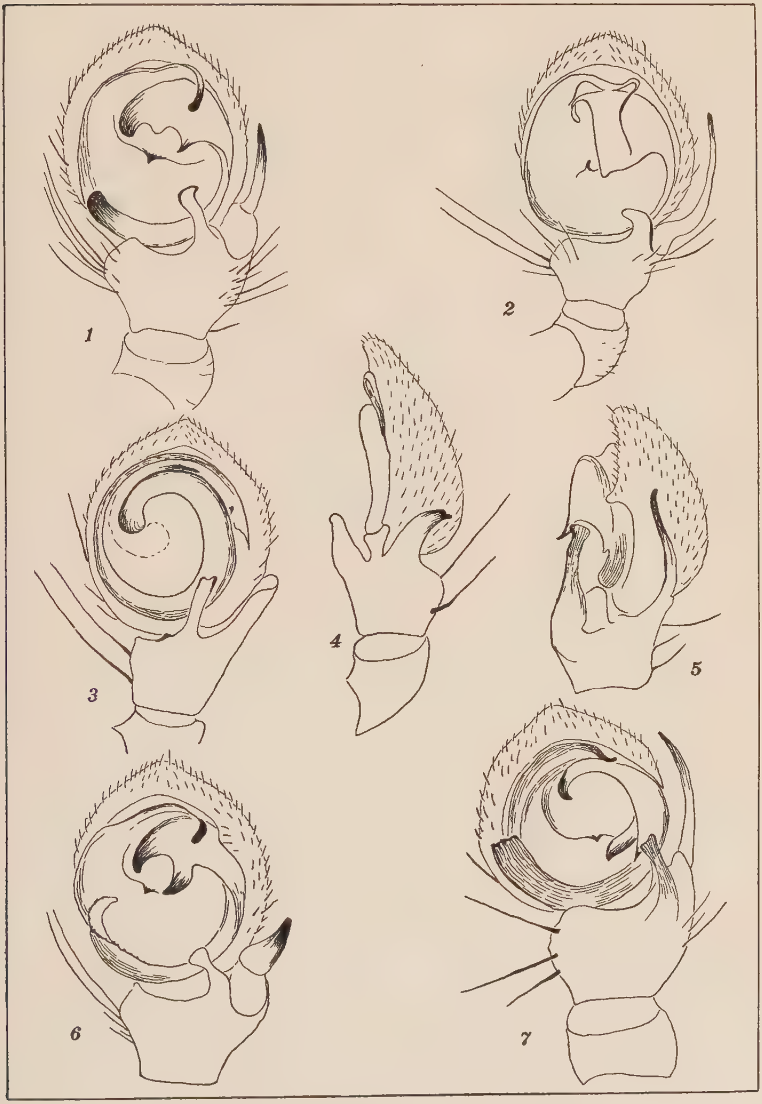
PLATE 19.

Fig. 8. *O. marshalli* Barrows, ventral view of palpus.
Fig. 9. *O. monroensis* Keys., ventral view of palpus.
Fig. 10. *O. marshalli* Barrows, lateral view of palpus.
Fig. 11. *O. neglecta* sp. n., lateral view of palpus.
Fig. 12. *O. pacifica* Banks, lateral view of palpus.
Fig. 13. *O. pacifica* Banks, ventral view of palpus.
Fig. 14. *O. neglecta* sp. n., ventral view of palpus.

PLATE 20.

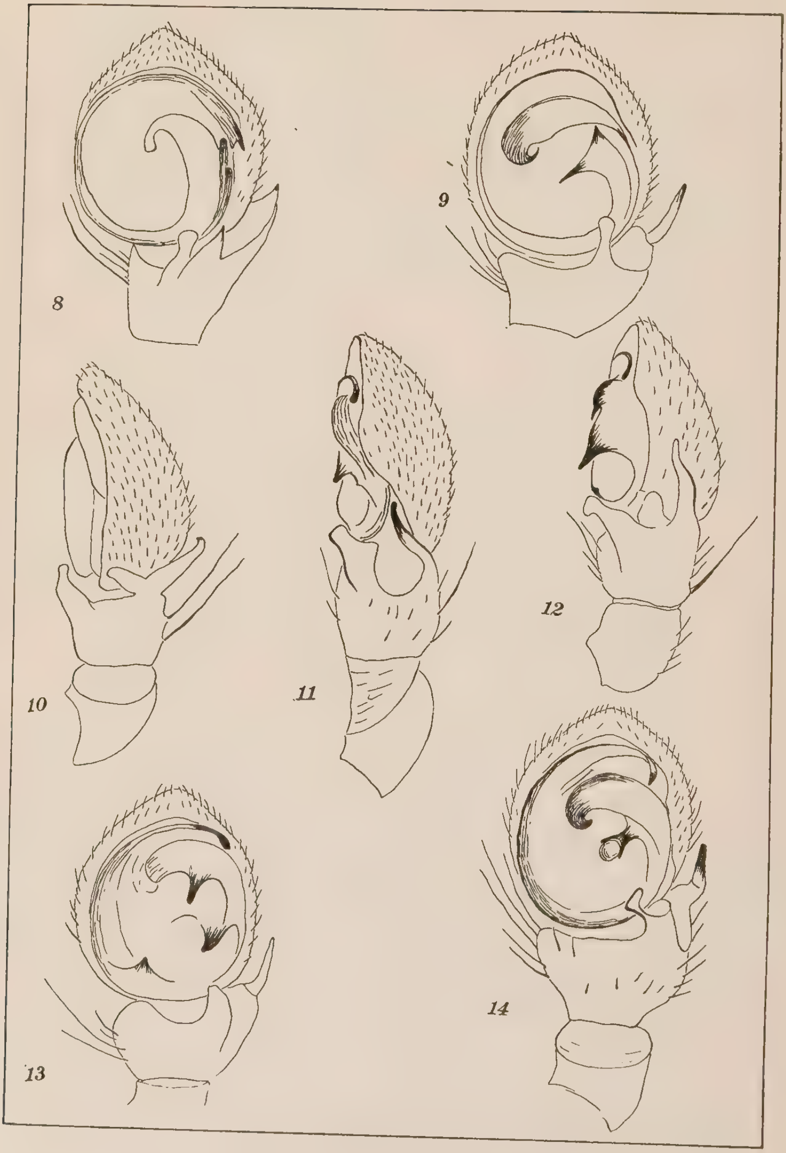
Fig. 15. *O. americana* Banks, epigynum.
Fig. 16. *O. conspurcata* Thorell, epigynum.
Fig. 17. *O. formosa* sp. n., epigynum.
Fig. 18. *O. floridana* Banks, epigynum.
Fig. 19. *O. monroensis* Keys., epigynum.
Fig. 20. *O. modesta* Keys., epigynum.
Fig. 21. *O. pacifica* Banks, epigynum.

Psyche, 1930 Vol. 37; Plate 18.



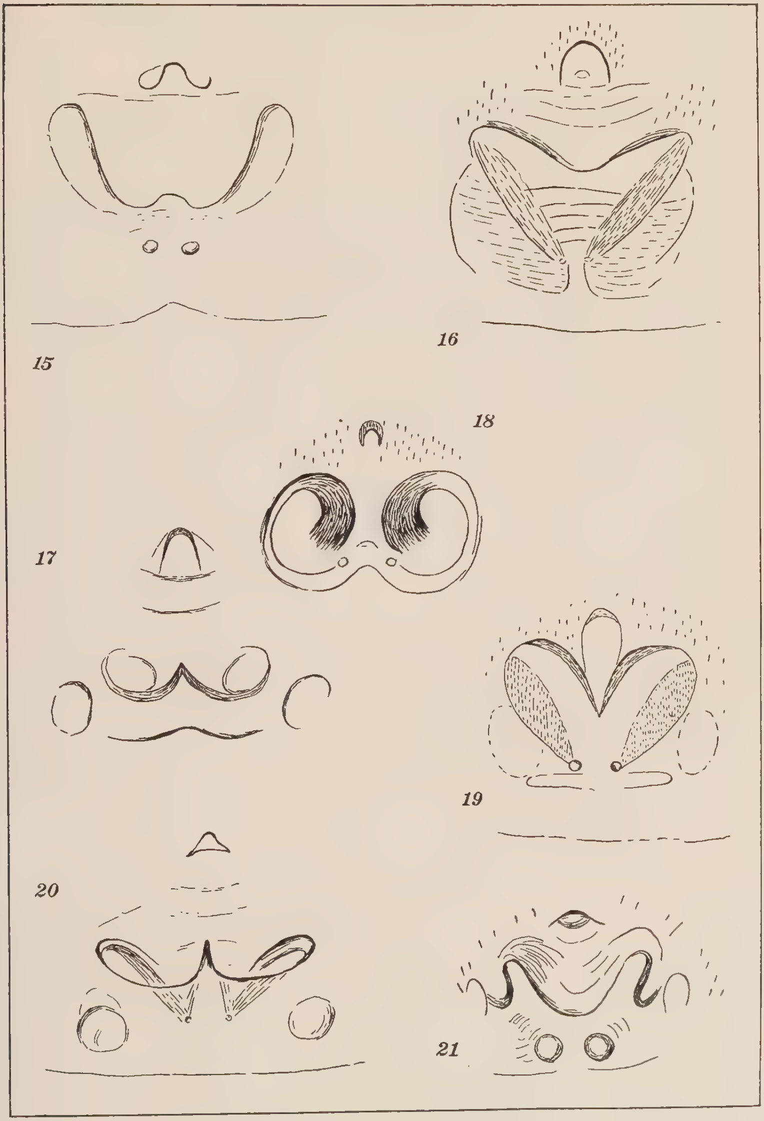
Bryant—American Ozyptila.

Psyche, 1930 Vol. 37, Plate 19.



Bryant—American Ozyptila.

Psyche, 1930 Vol. 37, Plate 20.



Bryant—American Ozyptila.

JEWELLED CADDIS-WORM CASES

BY CHARLES T. BRUES

During the summer of 1930 while collecting in the northwestern part of Nevada, I secured some caddis-worm cases which have interested me greatly on account of a striking peculiarity evinced by these larval Trichoptera in selecting the minute stones that serve as material for covering their cases.

We were returning from a sojourn in the far northwestern, almost uninhabited, desert portion of the state, where permanent water is to be found at very few places. Reaching Fish Springs at dusk we decided to camp for the night close to the spring which furnishes sufficient cold water to form a tiny stream and a series of several small pools before it is absorbed and disappears in the soil. Examining the spring and short stream the next morning, I noticed in the blackish mud that numerous minute glistening bits of opal flecked the dark background. It is not surprising to find opal at this place, as there are extensive deposits of opal and opalized wood in the contiguous country to the northeast, where the material is mined commercially. All the pieces in the spring were small or minute, but they emitted a brilliant pale blue fire.

We collected a number of aquatic insects and noticed a concerted movement of the fiery opal flecks upon the bottom, which proved to be a caddis-fly dragging its case across the surface of the mud. Search revealed a number of others and finally we obtained nine specimens, each thickly jewelled with bits of opal. As the amount of opal in the muddy bottom of the spring was far less in proportion to the other sandy or crystalline material than it is in the assortment utilized by the caddis-fly larvæ, there can be no doubt that the brilliant color of the opal in some way influences the larvæ in their choice. The cases are covered with sand,

and under the microscope the particles are seen to be in part crystalline (consisting of broken bits of highly refractive quartz) and in part dull opaque, usually yellow, brown or dark colored, non-crystalline material. The transparent particles are all opalized to some extent, although some are much more brilliant or "fiery" than others. A count of the particles from two cases, after removing them from the silken network by immersion in a caustic potash solution, shows that more than half are opalized to some extent. Thus in one case the ratio of crystalline and opalized particles to dull ones is 102:68 and in another 380:222. On the other hand, the amount of material from which selection is made by the larvæ shows a far smaller, though difficult to estimate, proportion of opal.

Several caddis-worms are known to exhibit a considerable intra-specific variation in selecting the material for their cases, depending usually upon what material is within reach. Lloyd ('21) describes a clear-cut example of this in *Limnephilus combinatus,* where he found either shells or bits of bark used by the larvæ in accordance with the availability of the two types of material. Here and in other species, *e. g.,* in *Phryganea vestita* and *Limnephilus submonilifer,* such differences are to some extent associated with age, as the younger and older larvæ build cases of a different structure, or again the larvæ may migrate as they mature and leave the area where certain materials are available. Some species are furthermore quite indiscriminate in their choice of building material.

It would seem that the sense of discrimination of caddis-worms in general in selecting objects to attach to their cases is such that it may be entirely dependent upon a tactile sense coupled with an appreciation of weight. Even where crystalline sand is chosen and rounded grains discarded, the same is true. Thus, the almost exclusive use of small quartz crystals by some species need not involve vision, as the latter may be recognized by their sharp edges.

In the present case vision must, however, form a necessary factor in the selection, as the brilliant opalized bits are not physically different from the white or slightly opalized pieces of quartz. All undoubtedly are of the same origin, having been formed as crystallization products in connection with fossilized wood that was silicified in extinct hot springs.

As a brief examination of the voluminous literature on caddis-worms has yielded no definite statements relative to the part played by vision in the choice of case-building material, it has seemed appropriate to present the accompanying observations.

I have not been able to determine the larva accurately, but it is structurally very similar to that of *Platyphylax designatus*, and undoubtedly belongs to some rather closely related form. Professor Banks has suggested that it may quite likely belong to one of two species of Heterophylax that are common in that part of the United States, *H. magnus* Banks or *H. occidentalis* Banks. On account of their size it is probable that they may be the latter species, as this is decidedly the smaller form.

CUBAN FULGORINA

1 THE FAMILIES TROPIDUCHIDAE AND ACANALONIIDAE

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and

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The present series of papers will deal with the Fulgorids of Cuba. It is our purpose not only to list the species which have been recorded previously from Cuba with critical bibliographic and taxonomic notes, but also to describe certain species which are apparently new. Special emphasis is placed on the male genitalia, as it is believed that these furnish the most reliable, specific characters. The descriptions will include only characters which may be readily observed by external examination. The internal genitalia of nearly all the species are illustrated by detailed drawings which are believed to be of more value than any attempt to describe these elaborate structures.

The specimens on which the present paper is based were collected largely by S. C. Bruner, J. Acuna and C. H. Ballou.

FAMILY TROPIDUCHIDAE

The family Tropiduchidæ was monographed in 1914 by Melichar. He listed only one species, *Tangia sponsa* Guerin, from Cuba, although Uhler, 1910a: 510, described *Cyphoceratops furcatus* from Cuba and Haiti. However, four years previously Pedro Valdes, 1910: 442, had recorded four species belonging to this family from specimens preserved in the Gundlach Museum, Havana, although the systematic position of all of these cannot be determined either from the names employed, which are badly misspelled, or from the word or two of description giving only the length and color of the insects. Osborn, in 1926c: 354, listed *Pelitropis rotulata* Van Duzee among the Fulgoridæ taken by him in Cuba, a species described from Florida and known also from Mississippi and North Carolina. Myers in a recent paper, 1928a:23, deals with two species of this family, *Neurotmeta sponsa* Guerin and *Remosa spinolæ* Guerin. A number of other genera and species have been recorded from the adjacent West Indian Islands, but so far as we know no other species heretofore assigned to this family have been recorded from Cuba. The present paper lists eight species, four species apparently being new. The synonymy and distribution of the other species are discussed.

Neurotmeta sponsa Guerin

This species was described by Guerin Meneville in 1856a: 180. This description was copied in Guerin Meneville, 1857a: 429. There is a brief popular description of this insect by Uhler, 1884a: 231. He lists it from Cuba, San Domingo and Florida, and assigns it to the genus *Tangia* Stal. The next reference to the species is by Van Duzee, 1907a: 35. But the insects which he collected in Jamaica and which we have examined are not the same as the Cuban material; "Elytra with a broad costal membrane crossed by numerous oblique veinlets." Melichar, 1914f: 100-101, redescribed the genus *Tangia* Stal with *Monopsis viridis* as the type, and then redescribes the species *sponsa,* which he assigns to Uhler. Van Duzee, 1917b: 739, assigns this species to the genus *Neurotmeta.* Metcalf, 1923a: 154, separated *Neurotmeta sponsa* from *Monopsis tabida* Spinola on the basis of the presence of costal cross-veins in the former and their absence in the latter. This is not a good character, however, as it is doubtful if the few irregular lines in the costal area can be interpreted as costal cross-veins. As has been pointed out by Melichar it would be better to separate these two genera on the basis of the branching of medius, the fork occurring near the base of the wing in *Monopsis* and near the middle of the wing in *Neurotmeta.* Otherwise these two genera are quite similar.

In *Neurotmeta* the costal vein is separated from the costal margin and connected apically with the costal margin by a series of short, indistinct transverse veinlets.

In this connection it might not be amiss to make a statement in regard to the status of the genus *Tangia* Stal. This genus was described by Stal, 1859a: 317-318, for three species *Monopsis viridis* Walker, and *Tangia kraatzi* and *Tangia schaumi* n. spp., *viridis* Walker differing in having no transverse veins in the costal area while these veins are present in the other two species. Melichar, failing to recognize that Guerin in describing *sponsa* and *spinolæ* had indicated the new genus *Neurotmeta,* made *viridis* the type of *Tangia* and erected a new genus *Tangiopsis,* including *Tangia kraatzi and T. schaumi* with *kraatzi* as the type. If *viridis* Walker is congeneric with *sponsa,* as the descriptions would seem to indicate, then *Tangia* Stal would be a synonym of *Neurotmeta* Guerin and *Tangiopsis* Melichar, with *Tangia kraatzi* Stal as type, is a valid genus. The name *Tangiopsis,* however, is preoccupied by *Tangiopsis* Uhler, 1901a: 512, haplotype *T. tetrastichus* Uhler, which is described as a Dictyopharid with a median ocellus. An examination of the type, through the kindness of Dr. E. D. Ball, reveals that this genus belongs to the *Tropiduchidæ,* falling into Melichar's tribe *Tambinini* near the genus *Amapala* Melichar. The median ocellus is not present, being represented by a small spot of glue or similar substance which simulates an ocellus. We propose the name *Tangella* type *Tangia kraatzi* Stal, 1859a: 318, to replace *Tangiopsis* Melichar, and would suggest that Van Duzee's *Tangia sponsa* belongs to this genus, although the vertex is very much prolonged, median length 1.75 times the width between the eyes.

Neurotmeta sponsa may be recognized by its distinct venation and by the short, broad, spatulate vertex. Fresh specimens are light green, but fade to dull tawny yellow. The last ventral segment of the female is short with the median length one-third the length of the lateral borders.

The male genitalia may be described as follows: The eighth ventral segment deeply incised on the median line, elevated in a U-shaped ridge almost to the base of the segment. The ninth segment short, ring-like, the posterior border when viewed laterally is strongly sloping cephalad. Genital plates large, extending caudad beyond the apex of the tenth segment. The ventral margins straight, contiguous, the apical border triangularly produced, the dorsal margin strongly curved with a distinct notch. The tenth segment spatulate, deeply notched, caudad; the anal notch deep; the anal spine small.

This species is common and widely distributed in Cuba. Specimens are at hand from Jarahueca, Oriente, July 14-18, 1927, S. C. B., on *Coffea arabica;* Nagua, Oriente, July 7, 1922, S. C. B. and C. H. B.; Santiago de las Vegas, June 12, 1920, Havana, S. C. B.; S. Nicholas, Oriente, July 20-21, 1927, S. C. B., taken at light; Camaguey, August 10-20, 1924, J. A., and Manzanillo, Oriente, July 31, 1922, S. C. B. and C. H. B.

Neurotmeta breviceps n. sp.

Head across eyes narrower than prothorax. Vertex, flat, somewhat more than twice as broad as median length, considerably produced in front of eyes, anterior margin obtusely angled, slightly rounded, posterior margin deeply incised to beyond anterior margin of eyes, lateral margins straight, parallel, median carina strong, lateral and anterior margins strongly but obtusely carinate. Pronotum, as long or slightly longer than median length of vertex, flattened above, strongly tricarinate as is also mesonotum. Venation, transverse line of veins to apex of clavus nearly straight, at right angle to longitudinal axis of elytra, costal membrane narrow, without distinct transverse veinlets.

Color, testaceous, but probably green in life.

Length, 7 mm., approximately.

Type, from Havana, Cuba, Dr. J. Gundlach, collector; in Gundlach Museum, Havana, No. 289, labeled "*Monopsis tabida* Spin."

The junior writer is indebted to Prof. Joaquin Folchs and Lieutenant Gonzalez of the Instituto de la Habana, for the privilege of examining this and several other specimens in the Gundlach Museum referred to in this paper.

In general facies this species resembles *Neurotmeta sponsa* Guer., except for much shorter vertex and broader form, aside from smaller size. It was listed by Valdés, 1910a, under the name given on the label in the Gundlach Museum, but it is quite distinct from *Monopsis tabida,* which does not appear to have been taken since the original description was published. Dozier, 1928a, says that *Monopsis tabida* was described from Cuban material, but he is evidently mistaken, as Spinola only mentions the "United States." On what authority the species has been listed by Van Duzee and others from Florida, we are unable to learn.

Pelitropis rotulata Van Duzee

This species is rather common in Cuba. Specimens are at hand from Omaja, Oriente, July 24, 1927, S. C. B.; Sto. Thomas, P. de Zapata; Sto. Clara, May 5-9, 1927, S. C. B. and J. A.; Santiago de las Vegas and Cojimar, Habana, S. C. B.; Sierra Rangel, P. del Rio, August 29, 1927, altitude 1500 feet; Camaguey, December 29, 1921, J. A.; and Nagua, Oriente, July 7, 1922, S. C. B. and C. H. B.

Nymphs are at hand from Nagua and from Santiago de las Vegas. They resemble the adult in a general way, being bright green in color with the carinæ tending toward bright orange. Vertex, distinctly spatulate, about as in the adult with the posterior border deeply incised and with a distinct median carina. Frons differs in having two strongly elevated median carinæ and a pair of intermediate carinæ which originate on the clypeal border about midway between the median carina and the lateral border and diverge upward, uniting with the carina at the apical border in front of the compound eyes.

Female genitalia, the last ventral segment of the female, is as long as the penultimate and about two-thirds as wide.

Male genitalia, eighth segment very short; deeply and roundly emarginate. Ninth segment ring-like, the caudal margins sinuate. Genital plates broadly triangular in outline, ventral margins slightly curved and contiguous. Tenth segment elongate, exceeding the genital plates. The caudal margins reflexed over the apex of the genital plates. Anal spines small, conical.

The name *Pelptiopsus mitratus* (Uhler MS) employed by Pedro Valdés (1910a: 443) for a specimen, No. 777, in the Gundlach Museum, Havana, is a synonym.

Colgorma Kirk

This name was proposed by Kirkaldy, 1904b: 279, to take the place of *Temora* Kirkaldy, 1901a :6, which was to take the place of *Rudia* Stal, 1866a :187, nec Costa 1861, Hymenoptera. Unfortunately *Temora* Kirkaldy, 1901, was preoccupied by *Temora* Baird, 1860, a genus of *Crustacea.* Since Stal, 1866c: 392, made *Achilus dilutus* Stal, 1859b: 271, the type of the genus *Rudia,* it is the type of the genus *Colgorma.* Melichar, 1914f: 79, uses *Temora* Kirk. with *Achilus dilutus* Stal as the type, and places it in the tribe *Tambiniini* and *Colgorma* Kirk with type *C. fowleriana* Kirk and places it in the tribe *Paricanini.* The tribe *Tambiniini* is distinguished from the tribe *Paricanini* by both Melichar and Muir because the genera in the former tribe have the "cross line distad of the middle of the wing," whereas in the latter tribe the "cross-vein is basad of the middle of the wing." Assuming that this is correct, and assuming further that *Rudia diluta* as figured by Fowler, 1904b, Pl. 11, Fig. 10, is correct and really represents *diluta,* as Fowler states that he compared his specimens with the type, *Colgorma* Kirk type *Achilus dilutus* Stal would fall in the tribe *Tambiniini* and would include *Temora* Kirkaldy as used by Melichar. This genus would include, therefore, the three species *C. diluta* Stal, *C. proxima* Fowl and *C. verticalis* Fowl. In regard to *Achilus bicinctus* Spinola, 1839a: 321, and *Rudia bicincta* Fowler, 1904b: 105, Kirkaldy, 1907b: 249, believed that these were distinct species, and he renamed the latter *Colgorma fowleriana.* Careful examination of the two descriptions and figures would lead us to believe that these are the same or closely related species. They differ in several respects from typical *Colgorma,* the most important being that the first branch of cubitus is not branched before the transverse line as it is in *Colgorma.* We would suggest, therefore, a new genus *Achilorma,* type *Achilius bicinctus* Spinola, and including the *Colgorma fowleriana* Kirk.

Our Cuban material includes two new species of the genus *Colgorma.*

Colgorma montana n. sp.

This species is close to *C. diluta* Stal as figured by Fowler; the head is narrower, the vertex longer and more pronounced, the frons narrower, meeting the vertex at an acute angle not broadly rounded as in *diluta.*

Vertex, elongate, about one and one-half times as broad as the median length; anterior margin broadly curved with a strongly elevated carina; lateral margins nearly parallel, carinæ distinct; posterior margin curved having the appearance of being triangularly incised because there is a triangular elevated area, the lateral margins of which extend from the posterior angles almost to the anterior margin of the vertex. Frons, about twice as long as its greatest width, appearing longer because it is distinctly narrowed between the eyes; central area almost flat, distinctly separated from the lateral margins by furrows which are characteristic of the genus; dorsal margin distinctly separated from the vertex by a transverse carina, the margin itself is straight and horizontal; lateral margins with an evident carina, nearly parallel to the lower margin of the eye, then gradually diverging for an equal distance, then converging to the clypeal margin which is narrower than the dorsal margin; clypeal margin broadly concave. Clypeus, elongate, triangular, obtuse, about one-third as long as the frons, shallowly inserted in the frons; central area strongly elevated, continuing the central area of the frons. Labium, short, the basal segment about one-half as long as the distal segment which is about one-half as long as the median segment. Genæ, distinctly separated from the frons and vertex. Antennæ, short; the basal segment, collar-like; distal segment capitate; flagellum elongate, about five times as long as the distal segment. Ocelli, distinct, placed below the ventral margin of the eyes. Compound eyes, sub-globular, ventral sinus indistinct. Pronotum, short, broad, median carina distinct; lateral carinæ strongly diverging, following the contour of the compound eyes. Fore legs, coxa, short, about as long as the diameter of the eye; femora, slender, elongate, about twice as long as the coxæ, prismatic, the margins with short, slender but distinct sub-erect setæ; fore tibiæ stout, about as long as the femora, prismatic, the margins lined with hairs as in the femora. Mesonotum, large, quadrangular; the median and lateral carinæ very distinct, the lateral carinæ converging anteriorly meeting on the median line. Tegulæ rather large; broadly elliptic with a horizontal carina. Fore wings, broad, the costal margin nearly straight, the apical border broadly rounded; costal vein broad, with fine tubercles on the apical half, these tubercles continuing around the apical margin; transverse line distinct but irregular; sub-costal-radial vein branching just anterior to the transverse line; medius united with radius for about one-half the length of the basal cell; cubitus one branched about two-thirds the distance between the basal cell and the transverse line; anal veins united for about two-thirds their length. Middle legs about as the fore legs but slightly longer. Hind femora elongate, somewhat capitate; hind tibiæ prismatic, longer than the femora with distinct sub-erect setæ on the margins, three evident spines on the lateral margins before the apex, two groups of spines at the apex, the lateral group of two elongate spines, and a median group with four shorter spines.

Male genitalia, eighth ventral segment short, collar-like; roundly emarginate posteriorly. Ninth ventral segment about three times as long as the eighth, the lateral margins sinuately curved. Tenth segment elongate spatulate, the apex broadly sinuate. Anal style short. Genital plates quadrate, the ventral margin curved, continuous along the median line.

Color, fresh specimens are pale olive green, more or less tinged with tawny, especially on the venter and legs. Wing veins in both fore and hind wing bright olive green. Eyes reddish brown. Antennæ greenish olive. Claws and tibial and tarsal spines black.

Size, length of apex to abdomen 4.5 mm. Length of the tip of the wing 5.1 mm. Width across the tegulæ 1.6 mm.

Types, Holotype, male, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B. and S. C. B. Allotype, female, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B.

and S. C. B. Paratypes, three males, one female, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B. and S. C. B., Pico Turquino, July 20, '22, S. C. B. and C. H. B. 5500 ft.

Colgorma campestris n. sp.

This species differs chiefly from *Colgorma montana* in the following points: the vertex is much shorter and broader; the wings are narrower and more elongate with the costal cell narrower and more elongate.

Vertex, broad and short, three times as long as broad; anterior margin broadly rounded; posterior margin triangularly incised; lateral margins parallel. Frons, broad; lateral margins nearly parallel, not narrowed between the eyes, slightly wider at the level of the antennæ; the median area broadly elevated. Clypeus, elongate diamond-shaped, triangularly inserted into frons; the median elevated area not conspicuous. Antennæ, with basal segment very short; apical segment capitate. Pronotum, short and broad; with median carina indistinct; lateral carinæ conspicuous; the lateral impressed points deep. Mesonotum slightly broader than long, about as 13 is to 10; median and intermediate carinæ distinct, intermediate carinæ converging anteriorly nearly parallel posteriorly. Fore wings, narrow, elongate, the costal cell narrow elongate.

Holotype male, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B.

Allotype female, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B.

Paratypes, one male, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B; one male, Barrio Caobilla, Camaguey, June 23-25, '27, J. A.; two females, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B; and one female, Nagua, Oriente, July 7, '22, S. C. B. and C. H. B.

Cyphoceratops furcata Uhler

This species was described by Uhler 1901a: 510 from Cuba and Port au Prince. We have seen one of the type series from Port au Prince through the kindness of Dr. E.

D. Ball. It agrees in all essential details with our series from Barrio Caobilla, Camaguey, June 23-25, '27, J. A. This genus was described by Uhler as belonging to the family *Cixiidæ*. It belongs, however, to the family *Tropiduchidæ* and the tribe *Tambiniini*. In Melichar's key it falls next to his genus *Amapala* with two species from South and Central America. It differs principally from this genus in cephalic and thoracic characters. The wing venation is apparently quite similar. The essential characters of this genus are well illustrated by the figures and need not be repeated. The general color is greenish testaceous, bright green on the frons between the carinæ and on the lateral fields of the pronotum. The carinæ of the frons, the lateral carinæ of the clypeus and a stripe on the lateral fields of the pronotum are bright orange red. The lateral carinæ of the vertex are bordered with black. There is also a broad irregular cloud of the same color on the genæ above the compound eyes, on the anterior margin of the mesonotum and on the bases of the wings, also on the lateral fields of the clypeus. Two irregular rings on the fore and middle femora and one at the apices of the fore and middle tibia and an irregular cloud on the hind femora are dark brown shading to black. The mesopleura have a conspicuous round black spot.

Male genitalia, the ninth segment is short and broad. The genital plates are about three times as long as the ninth segment with a distinct triangular tooth occupying the basal third, followed by a distinct notch apically. Tenth segment elongate, slender, deeply inserted into the ninth segment. Anal spine reaching about half way to the apex of the tenth segment.

There is also a specimen of this insect in the Gundlach Museum, Havana, labeled "*Steptocratus*, No. 328." Gundlach records this (MS notebook) as taken at "Rangel" (Sierra Rangel Mountains, Pinar del Rio).

Remosa spinolae Guerin

Myers 1928a: 23 places *Fulgora spinolæ* Guerin in the genus *Remosa* Distant after comparing specimens with the type of the genus. Melichar 1914f: 11 describes the genus as having the costal membrane broad with many cross-veins. Distant 1906n: 355 in the original description makes no mention of costal cross-veins, neither does Myers. The specimens we consider *spinolæ* have no costal cross-veins. The structural characters are indicated by the figures. This insect was listed by Pedro Valdés as *Dictyophora spinolæ* based on the specimen in the Gundlach Museum (No. 102) which is probably also the origin of the name employed by Osborn 1926c: 354.

The color of fresh specimens is bright olive green with the eyes orange brown, faded specimens are more or less testaceous.

Male genitalia, seventh segment elongate, the median notch strongly elevated, forming a triangular tooth. Eighth segment short, almost concealed by the seventh segment. The median length of the ninth segment about twice as long as the median length of the seventh segment, broadly emarginate posteriorly. Genital plates elongate, nearly three times as long as the median length of the ninth segment; contiguous ventrally; dorsal margin with a distinct triangular tooth, basally. Tenth segment spatulate; the apex notched. Anal spine elongate, extending about one-third of its length beyond the apex of the tenth segment.

Specimens are at hand from Camaguey, July 15, J. A., Jarahueca, Oriente, July 14-18, '27; Sierra Rangel, P. del Rio, August 29, '27, 1500 feet; Casa Blanca, Havana, June 2, '26, S. C. B. and Santiago de las Vegas, September 2, '23; J. A., and June 3, '27, S. C. B. and B. T. Barreto, on *Cestrum diurnum* L.

Ladella acunae n. sp.

This species differs principally from *Ladella pallida* Walk in the short transverse vertex. The vertex in *acunæ* is twice as broad as its median length whereas in *pallida* it is not as broad as its medan length.

Vertex, twice as broad as its median length; the anterior and lateral margins distinctly carinate, the anterior margin broadly rounded, the lateral margins parallel, the posterior margin nearly parallel to the anterior margin; median carina not strongly elevated. Frons, elongate, about one and one-half times as long as the greatest width, distinctly narrowed between the eyes; the lateral margins parallel to the level of the lower margin of the eyes, divergent to the level of the antennæ, suddenly converging to the narrower clypeus. Dorsal margin with a broad carina, the lateral margins strongly carinate, the median carinæ not strongly elevated. Clypeus broader and more elongate than in *pallida;* the lateral margins of the clypeus almost continuous with the lateral margins of the frons. Antennæ short, the second segment about four times as long as its basal width. Ocelli inconspicuous. Prothorax short, broad; anterior margin broadly rounded following the contour of the posterior margin of the vertex, the posterior margin broadly incised forming about a right angle; lateral margins straight, about as long as the median length; median carina distinct; intermediate carinæ converging to median line anteriorly, broadly diverging but not reaching the posterior margin; lateral margin with two distinct carinæ diverging posteriorly; lateral area of the pronotum almost quadrangular. Anterior legs short, weak; tibia shorter than the femora. Mesonotum large; median length about equal to its width between the tegulæ; median and intermediate carinæ strongly elevated meeting anteriorly on the median line and reaching the posterior margin. Fore wings, venation characteristic of the genus; the costal border relatively broader than in *pallida;* radius and cubitus forked at about the same distance from the basal cell, medius forked at slightly greater distance; transverse line irregular, crossveins in apical area few, some of which form a single distinct line. Hind legs, long, slender; tibiæ one and one-half times as long as the femora; tibiæ armed with three distinct spines, one near the apex, one near middle and one between these two; claws weak. Male genitalia, ninth ventral segment robust, broadly excavated posteriorly; genital plates elongate triangularly, rounded apically, meeting on the median line; tenth segment elongate, exceeding the genital plates, slender, spatulate; apex broad, rounded, notched.

Color, uniform pale green; spines on the posterior tibiæ and tarsi tipped with black; eyes concolorous.

Size, length to apex of wing 8.40 mm., width across tegular 1.90 mm.

Male Holotype, Los Llanos, Maisi, Oriente, Cuba. February 5, 1929, J. A.

FAMILY ACANALONIIDAE

In this family Guerin, Melichar, Osborn and Myers all record *Acanalonia servillei* Spinola from Cuba; Osborn records *Acanalonia sublinea* Walker; and Myers records an undetermined species. Our collection contains no less than seven species as indicated below.

Acanalonia servillei Spinola

This well known species has a wide distribution in the Southeastern states, having been recorded from Pennsylvania to Florida and in Cuba and Jamaica. We are inclined to question the Pennsylvania record of Amyot and Serville 1843a: 520. The short description would fit *Acanalonia latifrons* Walker, which was described later equally well and *latifrons* is the more northern species. The length given, 10 mm., is much nearer the average length of *latifrons* than it is of *servillei.* According to Melichar 1901a: 186 and Dozier 1928a: 110, this species is also found in South America but according to Distant 1910a: 298 the South American species is *A. laurifolia* Walker, which is distinct. *Servillei* may be recognized by its large size, 14-15 mm. to tip of wings, nearly uniform green color with the apical border of the wings marked by short brown dashes. The last ventral segment of the female is short with a short but distinct median flap with a curved posterior border. The width of the median flap is about one-fifth the width of the entire segment. In the male the genital plates are very broad, about three-fourths as broad as long. The tenth segment is short and broad, not reaching the apex of the genital plates. Anal style short, reaching about one-third the distance to the apex of the tenth segment; broadly spatulate in outline, bulbous at the base.

Specimens are at hand from Santiago de las Vegas, May, June and October, S. C. B., Hoyo Colorado, Havana, Camaguey, July 20, '23 and August 20, '24, J. A.; and from Mansanillo, July 31, '22, S. C. B. and C. H. B.

Acanalonia pumila Van Duzee

This species was described from Florida and has been recorded from Bermuda and North Carolina. Specimens are at hand from Isla de Pines, January 15, 1923, C. H. B., Barrio Caobilla, Camaguey, June 1927, J. A., Cojimar, Havana, July 1928, S. C. B., and Playa de Marianao, Havana, August 1927, S. C. B., Loma J. de la Torre, Oriente, January 1929, J. A. Also a pair of nymphs from the last locality. In general they resemble the adults. The frons is more elongate however, and has a double row of pustules along the lateral borders. These pustules are closely crowded and the inner row extends from the clypeal margin to the vertex and consists of about 13 distinct pustules. The outer row is shorter with about 8 pustules.

Female genitalia, the last ventral segment elongate; lateral and posterior borders distinctly sinuate to a rather deep notch on either side of the median projection which is about as long as the lateral margins of the segment and obtuse apically.

Male genitalia, the genital plates triangularly obtuse at the apex, exceeding the tenth segment by about one-fourth of their length. The tenth segment broad at the base; the anal groove broad and flat. Anal style elongate slender, bulbous at the base, the apex extending almost to the apex of the tenth segment.

Acanalonia impressa n. sp.

This species resembles *A. depressa* Melichar and *A. brevifrons* Muir. All three species have peculiar depressed vertexes. The present species is smaller than *depressa* but larger than *brevifrons*. From *brevifrons* it differs also in the more depressed vertex with the anterior margin nearly straight, not upturned as in *brevifrons*. The genital styles are not roughened in *impressa* as they are in *brevifrons*.

Vertex, impressed; its median length about half its width; surface smooth, somewhat shiny; anterior margin projecting in front of the eyes about one-half the median length; the posterior margin broadly rounded, indistinctly carinate; lateral margins about as long as the diameter of the eyes; diverging at an angle of about 20 degrees with strongly elevated carinæ which are continuous with the lateral carinæ of the frons and then curving abruptly caudad; lateral margins strongly carinate; nearly parallel but slightly diverging for about one-half the length and then abruptly converging to the clypeus; clypeal margin indistinct, the two arms forming an angle of about 45 degrees with each other. Clypeus, triangular, shallowly inserted in the frons, its width about three-fourths its length. Labrum, conical, about one-third the length of the clypeus; its surface distinctly hirsute. Epipharynx about one-half as long as the labrum. Labium, with basal segments small; second segment about twice as long as the distal segment. Mandibular sclerite small. Genæ, surface smooth, distinctly separated from the rest of the head by lateral carina of vertex and frons. Antennæ, short, length about one-fourth the diameter of the eyes; the basal segment about one-half as long as the distal segment; distal segment cylindric; flagellum slender, length about twice the diameter of the eye. Ocelli, evident, situated below the horizontal diameter of the eye. Compound eyes, large, ventral emargination indistinct. Pronotum, short, deeply impressed on either side of the median line; anterior margin rather broadly rounded, projecting about one-half its length; posterior margin very broadly rounded, not parallel with the anterior margin; lateral flaps large. Fore legs, coxæ large; femora stout, about as long as the coxæ without evident spines; tibiæ stout, prismatic; tarsi short, claws weak. Mesonotum, large, smooth, shiny; lateral carinæ indistinct; disc somewhat elevated, lateral areas strongly sloping; lateral borders elongate. Metanotum, small, triangular. Tegulæ, about as long as the diameter of the eye; somewhat crescentric with apices blunt. Fore wings, large; costal borders nearly straight; apical borders slightly rounded. Venation typical; stem of medius about twice as long as the basal cell, three branches occurring together, the first branch branching distad to the third branch. Middle coxæ shorter than the fore coxæ but about as stout; middle femora about as the fore femora with a row of six to eight indistinct teeth along the ventral anterior border. Middle tibiæ about as the fore tibiæ. Hind femora stout, about as long as the fore femora; hind tibiæ prismatic, distinctly clubbed apically, apex of the median face with two groups of teeth, one composed of two large teeth and the other of four small teeth. Hind tarsi, with the basal joint swollen with two large lateral teeth apically and a row of small teeth ventrally; claws short, stout.

Male genitalia, ninth segment broad, about three times as long as the eighth segment. Tenth segment short, not reaching the apex of the genital plate. Anal style short, robust, reaching about half way to the apex of the tenth segment. Genital plates elongate, nearly four times as long as its width; median border straight, contiguous throughout their entire length with an evident tooth dorsally; when viewed laterally genital plates are broadly triangular with the dorsal margin distinctly thickened posteriorly and projecting caudad as a blunt triangular tooth, and cephalid as a triangular tooth.

Female genitalia, last ventral segment short, the median flap short but distinct, its posterior border broadly rounded. Its width about twice its length.

Color, general color light green. The head and thorax tinged with tawny, especially on the carinæ and sides which are inclined to orange yellow; compound eyes dark with border distinctly black. Legs inclined to brown, the apex of femora and tibia externally more or less fuscous, with the claws and spines black. Fore wings with the costal and sutural borders tawny, the former paler anteriorly; the posterior half of the costal, apical and sutural borders distinctly marked with short brown dashes between the veins, the latter in large part faintly tinged with tawny. Hind wings milky with veins brownish. Abdomen tawny.

Size, length to apex of wings 10 mm; to apex of abdomen 6 mm; width across tegulæ 2.2 mm; length of wing 8.5 mm; width at apex 4.5 mm.

Holotype, male, Sierra Rangel P. del Rio, Cuba, August 29. Altitude 1500 feet. J. A. and S. C. B., on *Phoebe* *elongata*. Allotype, female, Barrio Caobilla Camaguey, Cuba, June 23-25, J. A. Paratypes, two males same as allotype and male, Baracoa, Oriente, Cuba, April 21-30, 1929, S. C. B. and L. Boucle.

Acanalonia lineata n. sp.

This species may be the same as the species listed by Osborn as *Acanalonia sublinea* Walk. It is apparently close to *A. viridis* Melichar. Walker gives no diagnostic characters of value for *sublinea* except length of body and length of wings. Our species is much smaller. Melichar gives as the chief diagnostic character for *viridis* "dass der innere Gabelast des N. ulnaris Ext. einfach ist," but it is evidently branched in the specimens before us.

Head across the eyes as wide as prothorax. Vertex, broad, about five times as broad as the median length; anterior margin confluent with the frons, broadly rounded when viewed laterally; posterior margin not concentric with the anterior margin, more deeply angularly emarginate; lateral margins diverging, definitely carinate. Frons, about one and one-third times as wide as long with a definite median carina; lateral margins carinate, slightly diverging to the level of the antennæ and then converging to the clypeus; clypeal margin fairly definite. Clypeus, conical, the median carina indistinct. Labium, basal segment short, intermediate segment elongate, robust; distal segment about two-thirds as long as the intermediate, slender. Antennæ, basal segment short, collar-like; distal segment broader than long, capitate with a definite apical notch. Flagellum, elongate, slender, longer than the great diameter of the eye. Ocelli, conspicuous at the level of the horizontal diameter of the eye. Compound eyes, large, ventral sinus small. Pronotum, broad, the dorsal field barely four times as broad as its median length, without carinæ or with faint median carina; anterior margin following contour of the head; posterior margin shallowly excavated; lateral fields large. Fore legs, coxæ elongate, about one-half as long as the femora; tibiæ prismatic, the margins distinctly elevated, ciliate with very short sub-erect setæ. Mesonotum, large, about three times as long as the vertex and pronotum together, wider across the tegulæ than its median length with a fine but distinct median carina. Tegulæ, very small, broadly U-shaped. Fore wings, subcosta short; radius elongate, breaking up into reticulations; medius branching into two branches at about the length of the basal cell, the costal branch branching again at about the same distance; claval branch unbranched; cubitus one unbranched. Middle coxæ, shorter than the fore coxæ, definitely conical; middle femora about as long as fore femora, stout; the ventral border carinate; middle tibiæ about as the fore tibiæ, the margins definitely short, ciliate. Hind legs, femora slightly longer and stouter than the fore femora; tibiæ about twice as long as the hind femora, distinctly clavate, the base slender, the apex with seven stout spines; tarsi with the basal segment stout, about twice as long as the intermediate, with a pair of stout lateral spines and eight short ventral spines.

Male genitalia, ninth ventral segment slender, elongate, about twice as long as the eighth; the genital plates very obtuse but slightly longer than the ninth segment; tenth segment elongate, slender deeply inserted in the ninth segment, not exceeding the genital plates; anal style short, slender, reaching one-third of the distance to the apex of the tenth segment.

Female genitalia, last ventral segment short, the median flap about as long as the lateral margins, its width about four times its median length.

Color, general color greenish, head and thorax fading to tawny olive green. Fore wings bright green, the apical margin marked with a row of indistinct brownish dashes. There is a distinct pale tawny line from the apex of the vertex to the tip of the mesonotum, which is continued along the commissural margins, where it is margined by indistinct brownish dashes. The pale tawny line from apex of vertex is absent in one of the paratypes. Legs tawny. The fore and middle tibiæ and hind tarsi brownish. Eyes dark brown.

Size, total length 8.25 to 9.00 mm., from apex of vertex to apex, 8.25 mm.; width of tegulæ, 2.10; total length of wings, 7.20; greatest width of wings, 4.70.

Holotype male, Barrio Caobilla, Camaguey, June 23-25, 1927, J. A. Allotype, female, Sto. Thomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A. Paratypes, male and female, Barrio Caobilla Camaguey, June 23-25, 1927, J. A.; female, Sto. Tomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A.

Acanalonia carinata n. sp.

This species resembles *A. umbraculata* Fabr., but is smaller, the median carina of the frons is very evident and extends to the base of the vertex.

Vertex, strongly sloping, confluent with the frons, anterior and posterior margins parallel, lateral margins strongly diverging. Frons, distinctly longer than broad, the side margins diverging slightly to the level of the eye and then converging to the clypeus, dorsal margins confluent with the vertex, median carina strongly elevated; a pair of intermediate carinæ start above the clypeal margins and diverge to the level of the dorsal margin of the frons, then converge to the base of the vertex where they are united by a transverse carina. Clypeus about as long as the width of the frons, median carina indistinct, the frontal margin indistinct, forming an obtuse angle. Antennæ, short, the basal segment collar-like, about one-half as long as the distal segment, which is short terete, the two segments together about one-fourth as long as the great diameter of the eye. Pronotum short, the anterior margin obtusely produced, the posterior margin shallowly excised; the impressed points small and shallow. Mesonotum, elongate without definite carinæ. Fore wings, elongate, relatively narrow, nearly twice as long as its greatest width. Medius three-branched.

Male genitalia, ninth segment elongate, tenth segment elongate, not reaching the apex of the genital plates; genital plates about twice as long as broad, obtuse, the dorsal angle strongly recurved in a blunt hook.

Color, grass green, the head, thorax, legs and abdomen fading to tawny, eyes clouded with black, claws and tips of spines black; margins of the wing fuscous or with fuscous dashes between veins.

Length, to the apex of wing, 6.50 mm.; length of wing, 6.00 mm.; width of wing, 3.20 mm.; width across tegulæ, 180 mm.

Holotype, male, Santiago de las Vegas, June 2, 1922, S. C. B. Allotype, female, Sto. Tomas, P. de Zapata, Cuba, May 5-9, 1927, J. A.. Paratypes, male Sto. Tomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A.; Habana, Nov., 1927; Sto. Fe, Is. de Pines, Sept. 6, 1926, S. C. B.; Wajay, Aug. 31, 1928, S. C. B., Santiago de las Vegas, Feb. 1, 1929, and May 24, 1928, S. C. B. Female, Calabazar, August 5, 1928, S. C. B.

Acanalonia viridula n. sp.

This species is close to *A. virescens* Stal, but the vertex is rounded anteriorly, not produced as in that species, and the wings are elongate.

Vertex, anterior and posterior margins nearly parallel, surface smooth, median carina indistinct. Lateral margins but slightly diverging, nearly parallel to the anterior margins of the eyes, strongly elevated. Frons, slightly broader than long, the median carina strongly elevated to the dorsal margin; lateral margins slightly diverging to the level of the antennæ and then strongly converging to the clypeus; clypeal margin distinct, the two limbs forming a right angle. Clypeus elongate, together with the labrum, longer than the frons. Antennæ, short, length about one-third the great diameter of the eye; basal segment, collar-like, distal segment capitate. Flagellum about as long as the great diameter of the eye. Pronotum short, its width to the tegulæ about six times its length; anterior and posterior margins not parallel, without carinæ. Fore legs, the fore tibiæ longer than the femora and trochanter together; femora stout, tibiæ prismatic, the margins strongly emarginate and ciliate. Mesonotoum about twice as long as the vertex and pronotum together; median and lateral carinæ evident. Middle legs, about the same as the fore legs, hind tibiæ elongate, clavate. Fore wings are elongate, nearly twice as long as their greatest width. Medius with three branches evident, the inner branch indistinctly forked near the apex.

Male genitalia, the ninth segment elongate, about one-half as long as the genital plates; the tenth segment reaching the apex of the genital plate, genital plates broad, their width about three-fourths their length, apex broadly rounded, distinctly ciliate.

Size, length to the apex of the wing, 7.50 to 7.75 mm.; width across the tegulæ, 2.20 mm.; total length of the wing, 6.60 mm.; greatest width, 3.50 mm.

Color, general color grass green, the head, legs and abdomen fading to tawny green, the eyes clouded with black. The flagellum, claws and spines of the legs tipped with black. Apical border of wings with short, indistinct fuscous dashes.

Holotype, male, Cape San Antonio, March 13, 1924, S. C. B. Paratype, male, Santiago de las Vegas, July 11, 1922.

Acanalonia gundlachi n. sp.

Head across eyes distinctly narrower than prothorax. Vertex, strongly produced into an acute angle, obtusely rounded at extreme apex, as long or somewhat longer than broad, about twice the length of pronotum, flat or very faintly concave over disc, slightly elevated towards apex, surface smooth, without carinæ, lateral margins sharp. Frons, flattened, meeting vertex at an acute angle. Pronotum, short, rather strongly impressed on either side of median line, anterior margin well rounded and extending between eyes to more than three-fourths distance to their anterior margin, posterior margin very broadly and shallowly emarginate, not parallel with anterior margin, surface smooth, without carinæ, somewhat flattened dorsally. Mesonotum, large, about four times as long as pronotum, smooth with faint indications of lateral carinæ, rounded above, disc not distinctly elevated. Fore wings, large, broad, broadest across center, narrowing slightly towards apex, strongly rounded before center, then straight, apical margin vertical, nearly straight, slightly rounded. Venation, prominent, medius long, strongly elevated. Color, bright green; fore wings very narrowly bordered with tawny, broader on sutural margins; the elevated medius appearing pale orange testaceous; legs brownish testaceous.

Size, length to apex of tegmen, 13 to 15 mm.

Holotype and paratype from Yateras, Oriente Province, and Monte Toro, Cuba, Dr. J. Gundlach, collector; in the Gundlach Museum, Habana, Cuba, No. 344.

The above brief description was made from the two specimens preserved in the Gundlach Museum in a sealed, glass-covered box, from which they could not be removed for more careful study. This striking species is not easily confused with anything else reported from the West Indies. It appears to be related to the very recently described *Acanalonia coniceps* Osborn from Porto Rico (Jour. Dept. Agric. Porto Rico, 3, pp. 108-109, July, 1929—issued November, 1929), but is much larger.

Acanalonia insularis n. sp.

This species resembles *Acanalonia lineata* in general appearance, but is much smaller, 6.5 mm., as contrasted with 9.5 mm. of the other species. The genitalia is also decidedly different. It resembles *carinata* in having the diverging intermediate carinæ, but differs in having the shorter, somewhat broader frons and in having relatively narrow and more elongate wings. The genitalia is also decidedly different from those of *carinata.*

Vertex, somewhat elongate with median length slightly more than one-half the width between the eyes; median carina fine, distinct; anterior margin broadly triangular; lateral margin slightly diverging. Frons, nearly as broad as long; lateral margins parallel to the level of the antennæ and then converging to the clypeus. Median carina distinct; a pair of intermediate carinæ arise about the middle of the frons and diverge to the lateral margin. Clypeus, short, about as long as broad. Pronotum, short, with its median length about two-thirds as long as the median length of the vertex; anterior margin obtusely produced; posterior margin broadly sinuate. Mesonotum, longer than broad, ecarinate. Fore wings, rather short and broad; medius, three-branched.

Male genitalia, ninth segment elongate; tenth segment short, reaching about two-thirds of the distance to the apex of the genital plates. Genital plates, broad, obtuse; dorsal angle broad, not recurved.

General color, grass green, with the tips of the tibia and the tarsi fading to tawny. Eyes, chocolate color. Claws and spines black. Costal and apical margins of wings with fine black dashes between the veins. A median pale stripe extends from the apex to the vertex across the pro and mesonotum to the apex of the claws.

The length to the apex of wings, 6.80 mm. Length of wings, 5 mm. Greatest width of wings, 4.50 mm.

Holotype: Male, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B.

Allotype: Female, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B.

Paratypes: Male, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B. Female, Nuena Gerona, Isla de Pinos, Sept. 12, 1928. S. C. B.

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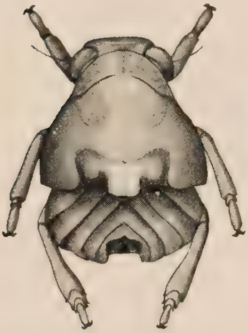
Plate 22. Outlines of head and thoracic characters of Cuban Tropiduchidæ and Acanalonidæ.

Plate 23. Wings of Cuban Tropiduchidæ.

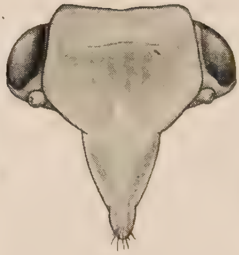
Plate 24. Male Genitalia of Cuban Tropiduchidæ.

Plate 25. Male genitalia of Cuban Acanalonidæ.

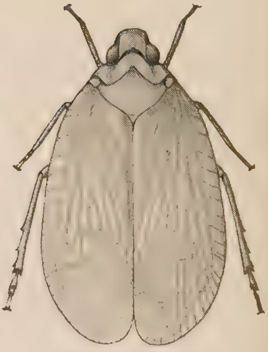
Psyche, 1930 VOL. 37, PLATE 21.



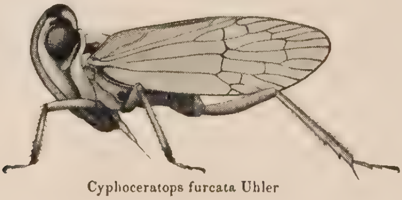
Acanalonia pumila Van D. nymph



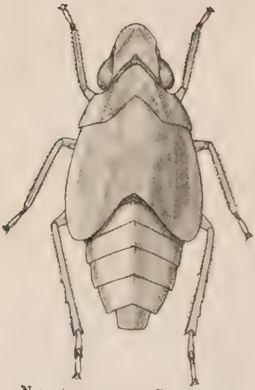
Acanalonia impressa n.sp.



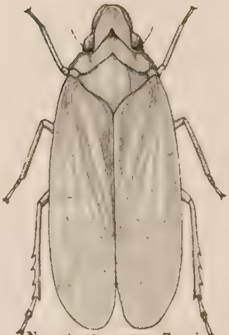
Ladella acunae n.sp.



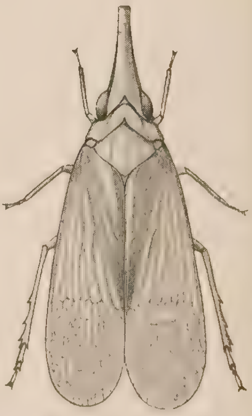
Cyphoceratops furcata Uhler



Neurotmeta sponsa Guerin.nymph.



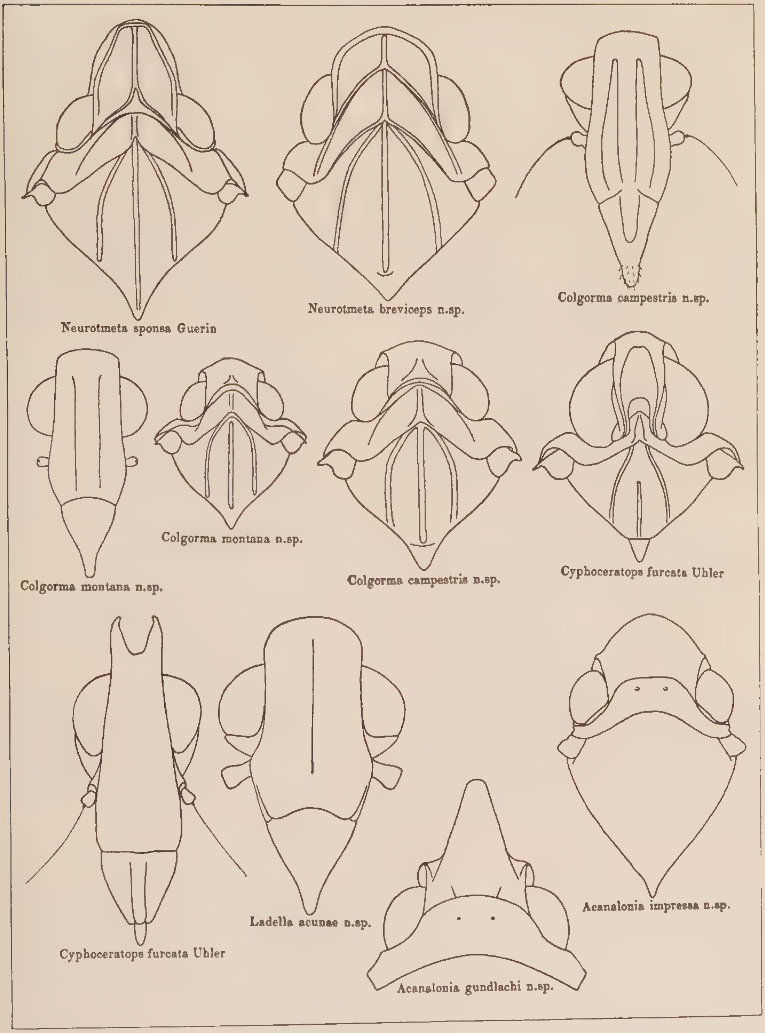
Neurotmeta sponsa Guerin



Remosa spinolae Guerin

Metcalf and Bruner—Cuban Fulgorina.

Psyche, 1930 VOL. 37, PLATE 22.



Neurotmeta sponsa Guerin

Neurotmeta breviceps n.sp.

Colgorma campestris n.sp.

Colgorma montana n.sp.

Colgorma montana n.sp.

Colgorma campestris n.sp.

Cyphoceratops furcata Uhler

Cyphoceratops furcata Uhler

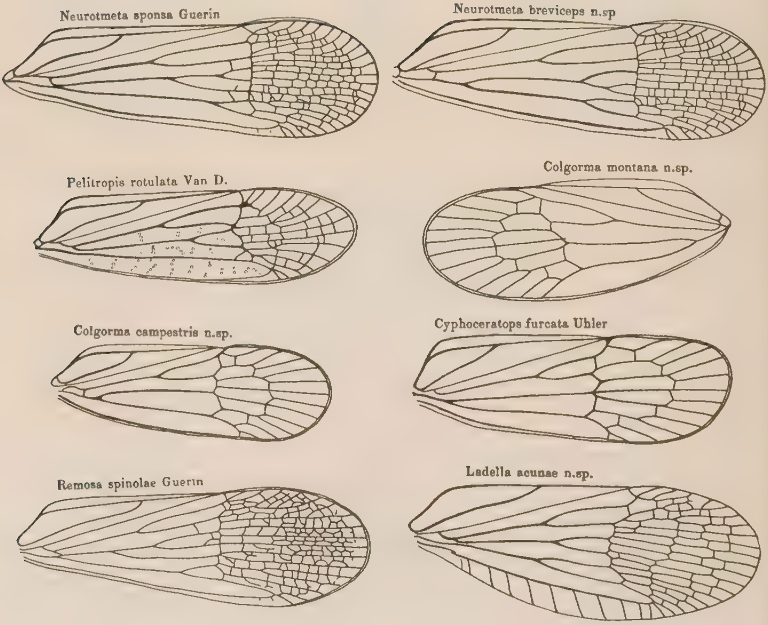
Ladella acunae n.sp.

Acanalonia gundlachi n.sp.

Acanalonia impressa n.sp.

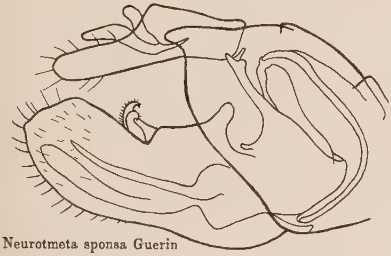
Metcalf and Bruner—Cuban Fulgorina, Head and Thoracic Characters.

Psyche, 1930 VOL. 37, PLATE 23.

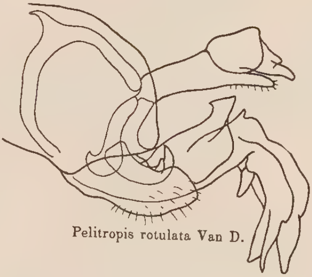

Neurotmeta sponsa Guerin
Neurotmeta breviceps n.sp
Pelitropis rotulata Van D.
Colgorma montana n.sp.
Colgorma campestris n.sp.
Cyphoceratops furcata Uhler
Remosa spinolae Guerin
Ladella acunae n.sp.

Metcalf and Bruner—Cuban Tropiduchidæ, Fore Wings.

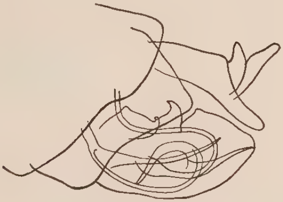
Psyche, 1930 VOL. 37, PLATE 24.



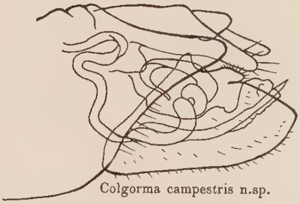
Neurotmeta sponsa Guerin



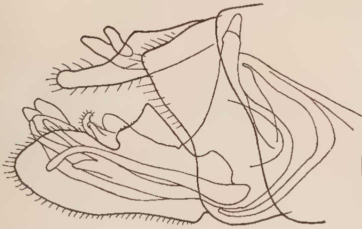
Pelitropis rotulata Van D.



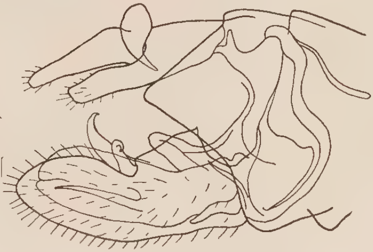
Colgorma montana n.sp.



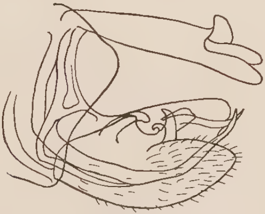
Colgorma campestris n.sp.



Cyphoceratops furcata Uhler



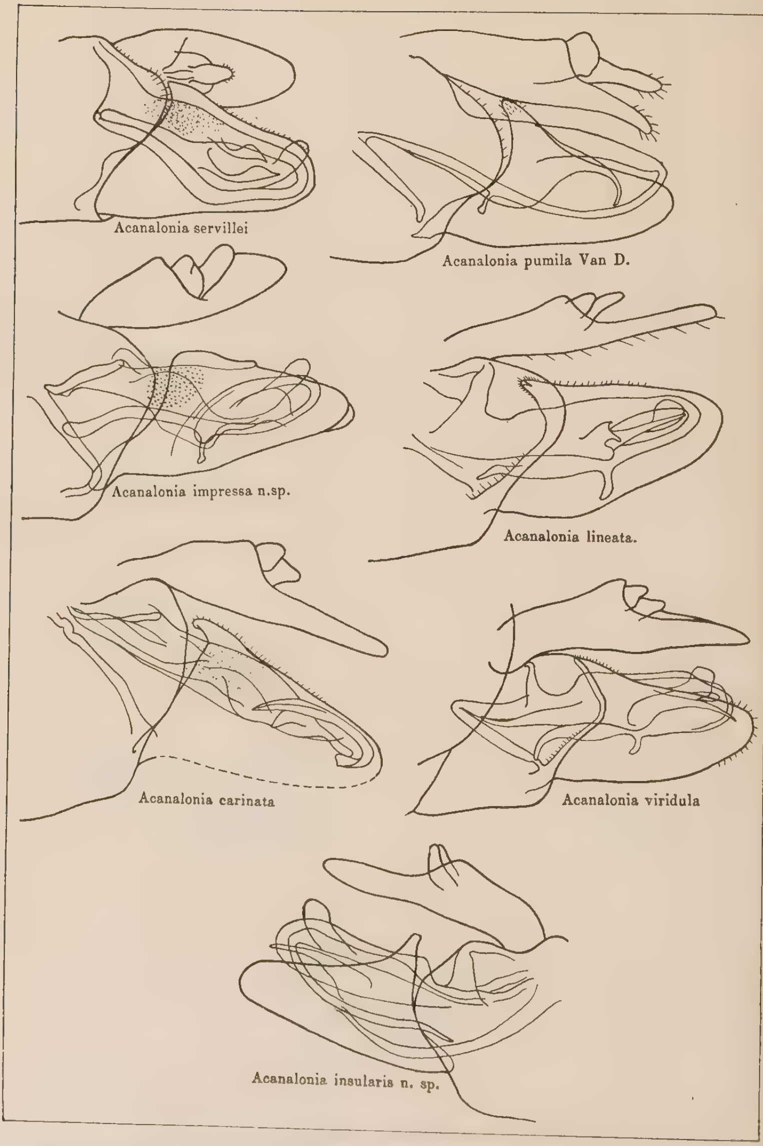
Remosa spinolae Guerin



Ladella acunae n.sp.

Metcalf and Bruner—Cuban Tropiduchidæ, Male Genitalia.

Psyche, 1930 VOL. 37, PLATE 25.



Acanalonia servillei

Acanalonia pumila Van D.

Acanalonia impressa n.sp.

Acanalonia lineata.

Acanalonia carinata

Acanalonia viridula

Acanalonia insularis n. sp.

Metcalf and Bruner—Cuban Acanaloniidæ, Male Genitalia.

PSYCHE

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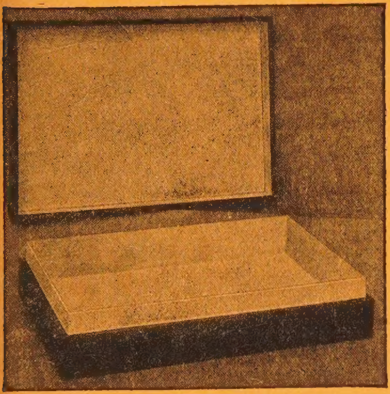

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